ASC R-120

NAVAL AIRCRAFT OPERATING AND SUPPORT COST-ESTIMATING MODEL - FY77 REVISION

CONTRACT NO. N00014-77-C-0180

February 1979

Prepared for

Office of the Chief of Naval Operations
Advisor for Resource Analysis (OP-96D)
The Pentagon
Washington, D.C. 20350

Administrative Sciences Corporation

ALEXANDRIA, VIRGINIA

ASC R-120

NAVAL AIRCRAFT OPERATING AND SUPPORT COST-ESTIMATING MODEL - FY77 REVISION

CONTRACT NO. N00014-77-C-0180

February 1979

Prepared for

Office of the Chief of Naval Operations
Advisor for Resource Analysis (OP-96D)
The Pentagon
Washington, D.C. 20350

CONTENTS

ABSTRACT

In fiscal 1974, Administrative Sciences Corporation developed a parametric cost-estimating model for the Chief of Naval Operations, Advisor for Resources Analysis (Op-96D). This model which has been updated and documented several times, has been used to support numerous Defense Systems Acquisition Review Council (DSARC) reviews as well as other cost reviews and studies. This report provides a detailed documentation of the cost-estimating relationships (CER's) developed from the FY77 data. In addition, the report has been significantly enhanced in order to serve as a handbook and training aid for Op-96D aircraft analysts. For each cost element in the structure, this report provides:

1. a definition;
2. a discussion of the definition and other aspects of how, where, and why these costs are incurred, points of contact including organizational codes and telephone numbers, historical data, and sources for planning data;
3. a cost-estimating relationship, including all computational procedures, regression statistics for the CER, and the data base;
4. an alternative CER (in many cases) with the same detail as above; and,
5. an example calculation.

This report also provides complete documentation for the computerized version of the model which has been programmed on the Op-96D system. It consists of User Instructions, Sample Runs and Program Code. There are two other

aspects of this report which should be mentioned. An effort was made, both throughout the text and with a special exhibit, to assist the reader in translating the DSARC cost elements into a Program Objectives Memorandum (POM) format. Obviously much more work is necessary to do this completely, but this does serve as a beginning. Secondly, there was an effort made to evaluate the products of the Visibility and Management of Support Costs (VAMOSC-AIR) System and their suitability for use by OP-96D. An analysis of this is being prepared and will be forwarded to OP-96D under separate cover.

I. EXECUTIVE SUMMARY

This report is the fourth report documenting the Administrative Sciences Corporation Aircraft Operating and Support (O&S) Cost Estimating Model. The model which is continuously updated as new data becomes available or as maintenance policy dictates, is operational on both the Op-96D and ASC computer systems. This report, however, is significantly different from previous ones describing the model, because it has been significantly enhanced. It not only documents the model, but it contains extensive discussions of Naval aircraft operations, O&S data systems, cost analysis, and other topics. It is designed to serve as a training aid for Op-96D aircraft analysts, picking up where the "Op-96 Standard Operating Procedures" or "Red Book" leaves off, and supplying a complete estimating capability except for the analysts' judgment. Each cost element is defined and discussed in detail including the availability and accuracy of the various data sources, points of contact for further data or explanation, computation of workload and other pertinent factors, one or more cost-estimating relationships, and an example calculation. Where the element does not lend itself to analytical description, a set of representative data are given. Considerable other background information is contained in the body of this report and Appendices A-C. In summary, after an analyst reads and understands this report, he will have obtained an extensive knowledge of the operation and support of Naval aircraft as well as a sophisticated estimating capability.

Several exhibits have been included in this section to provide a summary of the analytical work which has been done and a quick reference guide for the users. Exhibit I-1 provides the cost element structure (CES) used in this report and the appropriation, claimant, and budget activity/program title of each element. This serves as a crosswalk to the budget or Program Objectives Memorandum (POM) to show where the life cycle O&S costs estimated in an acquision review impact the budget. Exhibit I-2 provides a summary of the cost-estimating relationships. Exhibit I-3 gives an alphabetical listing and definitions for each variable used in this report; and, Exhibit I-4 provides a summarization of the points of contact for each element. Appendices D, E and F which constitute a user's manual, provide explicit instruction, including examples, for executing the computerized model on the OP-96D system.

Finally, this report has put much emphasis on the discussion of data sources, especially the evaluation of a significant new one - the Visibility and Management of Support Costs (VAMOSC-AIR) System, (also known as NALCOMIS-O&S). It is important to note however, that as visibility of costs increases, there are two O&S cost elements which are emerging as significantly larger and therefore, more important than would have been anticipated by their previous treatment. The two elements are Modifications (Element 21) and Training Expendable Stores (Element 23). The data given in this report for Modifications would indicate that in total, it is larger than either Airframe Rework (Element 12) or Engine Rework (Element 13) and in some cases

EXHIBIT I-1

NAVY OPERATING AND SUPPORT COST
ELEMENT STRUCTURE FOR AIRCRAFT SYSTEMS

	Appropriation	Program Package/ Claimant	Budget Act/Program Title	Accounting Visibility[1]
Deployed Unit Operations				
1. Aircrew (Officers)	MPN	CINC	II - General Purpose Forces[2]	D
2. Aircrew (Enlisted)	MPN	CINC	II - General Purpose Forces[2]	D
3. Combat Command Staff	MPN	CINC	II - General Purpose Forces[2]	D
4. Aviation POL	O&MN	CINC	II - General Purpose Forces[2]	D
5. Other Deployed Manpower	MPN	CINC	II - General Purpose Forces[2]	D
6. Air TAD	O&MN	CINC	II - General Purpose Forces[2]	D
Below Depot Maintenance				
7. Aircraft Maintenance Manpower	MPN	CINC	II - General Purpose Forces[2]	D
8. Maintenance Material	O&MN	CINC	II - General Purpose Forces[2]	D
9. Personnel Support Supplies	O&MN	CINC	II - General Purpose Forces[2]	D
Installation Support				
10. Base Operating Support	O&MN, MPN	NAVAIR, NAVSEA	VII - Central Supply and Maintenance	I
Depot Maintenance				
11. Component Rework	O&MN	NAVAIR	VII - Cent.Sup.& Maint./Aircraft Reworks	A
12. Airframe Rework	O&MN	NAVAIR	VII - Cent.Sup.& Maint./Aircraft Reworks	D
13. Engine Rework	O&MN	NAVAIR	VII - Cent.Sup.& Maint./Aircraft Reworks	D
Depot Supply				
14. Depot Supply Operations	O&MN	NAVSUP	VII - Cent.Sup.& Maint./Supply Depot Ops.	A/I
15. Technical Support	O&MN	NAVAIR	VII - Cent.Sup.& Maint./Procurement Ops	A/I
			VII - Cent.Sup.& Maint./Operational Support Facilities	
			VII - Cent.Sup.& Maint./Field Ops.	
			VII - Cent.Sup.& Maint./Logistic Support Services	
			VII - Cent.Sup.& Maint./Installation,Maint.& Ovh.of Equip.	
			VII - Cent.Sup.& Maint./Maint. Engs.& Support Services[2]	
16. Second Destination Transportation	O&MN	NAVSUP	VII - Cent.Sup.& Maint./Second Destination Trans.	I
Personnel Support and Training				
17. Individual Training	O&MN,MPN	CNET,	VIII - Trng.Med.&Oth.Gen.Pers.Act/Recruit Trng.	I
			VIII - Trng.Med.&Oth.Gen.Pers.Act/Specialized Trng.	
			VIII - Trng.Med.&Oth.Gen.Pers.Act/Prof. Devel. Ed.	
			VIII - Trng.Med.&Oth.Gen.Pers.Act/Officer Acquisition	
			VIII - Trng.Med.&Oth.Gen.Pers.Act/Flight Training	

EXHIBIT I-1 (cont'd.)

NAVY OPERATING AND SUPPORT COST
ELEMENT STRUCTURE FOR AIRCRAFT SYSTEMS

	Appropriation	Program Package/ Claimant	Budget Act/Program Title	Accounting Visibility
18. Health Care	O&MN, MPN	BUMED	VIII - Trng.Med.&Oth.Gen.Pers.Act	I
19. Personnel Activities	O&MN, MPN	BPers,Chief of NavPers	VIII - Trng.Med.&Oth.Gen.Pers.Act	I
Sustaining Investments				A
20. Replenishment Spares	APN-6	NAVAIR	II - General Purpose Forces	A
21. Modifications	APN-5	NAVAIR	II - General Purpose Forces	I
22. Replenishment Ground Support Equip.	APN-7	NAVAIR	II - Genersl Purpose Forces	A/I
23. Training Expendable Stores	WPN	NAVAIR	II - General Purpose Forces	

[1]Direct Cost with Individual weapon system visibility

[2]Denotes the most common application. Under certain circumstances costs may be funded by other Programs.

EXHIBIT I-2

Cost Elements	Definitions	CER	Reference
Deployed Unit Operations			
1. Aircrew (Officers)	Officer Aircrewmen	OA = O x CF x OPR	Based on program information
2. Aircrew (Enlisted)	Enlisted Aircrewmen	EA = E x CF x EPR	Based on program information
3. Combat Command Staff	Non-flying Command Admin. Pers.	CCS = (OC x OPR) + (EC x EPR)	Based on program information and squadron size
4. Avlation POL	Fuel and additives for A/C	POL = (POLF x FHY)/1000; POLF = $0.2987GT^{0.4403}{}_{MS}{}^{0.7986}$	Based on actual usage, Op-51C data.
5. Other Deployed Manpower	Varions utility and miscellaneous personnel not previously counted	ODMC = ODM x EP; ODM = $-0.5030 + 0.2231SP^{0.5000}$	Based on OpNAV policy
6. Air TAD	Travel and TAD expenses to obtain maintenance and other training	Throughput (See Table IV-3)	Based on VAMOSC data
Below-Depot Maintenance			
7. Aircraft Maintenance Manpower	Squadron O&I level maintenance pers.	AMM = MO x EPR; MO = 1.6700 + 0.0180MMHMO	Based on 3-M data and OpNAV policy
8. Maintenance Material	Non-repairable O&I level maintenance material	MMC = (MM x FHY)/1000; MM = (-22.6417 + 0.1323MS + 0.1407MMHMO) x 0.94	Based on actual data Op-51C
9. Personnel Support Supplies	Non-maintenance O&I level material	PSS = (PS x FHY)/1000; PS = (-22.6417 + 0.1323MS + 0.1407MMHMO) x 0.06	Based on actual data Op-51C
Installation Support			
10. Base Operating Support	Cost of base support services to squadron	BO = 0.0013TDP; BE = 0.0172TDP BOM = 445.5947 x TDP; BOS = (BO x OPR) + (BE x EPR) + BOM	NARM methodology, Proxy-number of squadron pers.
Depot Maintenance			
11. Component Rework	Depot repair of repairables	CR = (CRF x FHY)/1000; CRF = 43.2996 + 2.9875MMHFH + 174.5500AD	Based on VAMOSC data

EXHIBIT I-2 (cont'd.)

Cost Elements	Definitions	CER	Reference
12. Airframe Rework	Depot repair/overhaul of airframe	AR = (UAR x 12)/1; UAR = -54.9255 + 0.1574MMHMO + 0.1354MS	Based on data from Naval Air Rework Facilities
13. Engine Rework	Depot repair/overhaul of engine	$ERT = \frac{(ORR \times ERO) + ERM}{(1 + ORR) \times DAR} \times EN \times FHY$ ERO = 28.8755 + 1.6700TH + 87.7879FD; ERM = 12.5968 + 0.8153TH + 7.8157FD	Based on data from Naval Air Rework Facilities and 3-M System
Depot Supply			
14. Depot Supply Operations	Cost of supply depot support for A/C parts and squadron material	SDO = 0.0247DR	NARM Methodology, Proxy all other costs
15. Technical Support	Large number of technical support programs	TS = 0.4760RS + 0.3317ACR + 0.1941ACO -SDO - SDT	NARM Methodology, Proxy - all other costs
Second Destination Transportation			
16. Second Destination Transportation	SDT costs of A/C and squadron material	SDT = 0.0572DR	NARM Methodology, Proxy - all other costs
Personnel Support and Training			
17. Individual Training	Training costs up to Readiness Squadron	TOM = 0.0040DBE + 0.0701DBO + 0.2798DBT; TO = 0.0605DBO + 0.0027DBT + 0.0001DBE; TE = 0.0934DBE + 0.0209DBT + 0.0067DBO; TT = TOM + (TO x OPR) + (TE x EPR)	NARM Methodology, Proxy - Squadron and base operating enlisted, officer & total
18. Health Care	Cost of providing health care to squadron and BOS personnel	HO = 0.0099DBT; HE = 0.0192DBT HOM = 0.3765DBT	NARM Methodology, Proxy - Squadron and base operating enlisted, officer & total
19. Personnel Activities	The cost of a number of personnel programs	PCS = 1.2930DBO + 0.4460DBE; REOM = 0.0635DBE; REO = 0.0009DBE; REE = 0.0072DBE OH = 0.0008DBO; EH = 0.0124DBE 0.0606DBO; TET = 0.0447DBE; TPA = REOM + (REO + OH + TOT) x OPR + (REE + EH + TET) x EPR + PCS	NARM Methodology, Proxy - Squadron and base operating enlisted, officer & total

EXHIBIT I-2 (cont'd.)

Cost Elements	Definitions	CER	Reference
Sustaining Investments			
20. Replenishment Spares	The cost of purchasing replenishment reparable material	RS = (RSF x FHY)/1000; RSF = 4.5(-2.9149 +0.0194MS + 0.0073MMMO)	Based on VAMOSC data - scaled to approximate budget
21. Modifications	The cost of safety mods for A/C and equipment	$M = 0.0041FC_{100}$	Cost Factor
22. Replenishment of Ground Support Equipment	The cost of replacing GSE	$RGSE = 0.0025FC_{100}$	Cost Factor
23. Training Ordnance	The cost of all expendables used in training	Determined by A/C weaponry and training requirements. See Table C-7, Appendix C	Refer to Table C-7, Appendix C for guidelines

EXHIBIT 1-3

ALPHABETICAL LISTING OF VARIABLES

Variable	Definition	Cost Ele. Ref.
a	the annual attrition rate	V
ACO	the annual cost of aircraft operations, which is the sum of Aviation POL - Element 4, Maintenance Material - Element 8, and Personnel Support Supplies - Element 9	15
ACR	the annual cost of aircraft rework which is the sum of Component Rework - Element 11, Airframe Rework - Element 12, and Engine Rework - Element 13 (FY77$K)	15
AD	an avionics dummy variable such that AD = 1 for reconnaissance, electronics, ASW, and patrol aircraft AD = 0 otherwise	11
AMM	the cost of aircraft maintenance manpower	7
AR	the annualized cost of an airframe rework	12, 15
AT	the cost of AIR TAD	6
BE	the number of base operating enlisted personnel required to support the aircraft system	10
BO	the number of base operating officers necessary to provide support to the aircraft system	10
BOM	the O&M funds necessary to provide base support to the aircraft system	10
BOS	the total cost (O&MN and MPN) of base operating support services	10
CCS	the cost of combat command staff manpower	3
CF	the crew factor	1,2,5
CR	the annual cost of component rework (FY77$K)	11,15
CRF	the cost per flying hour of component rework	11
CSR_I	the composite standard rate of pay for personnel in the ith pay grade	1,2,3,5,7
D	the engine diameter in inches	13
DAR	the depot arrival rate in operating hours, i.e., the total operating hours accumulated by the engines divided by the number of engines requiring depot repair	13
DBE	the total number of enlisted personnel, direct plus base operating, required to operate and provide base support to the aircraft system	10,17,19
DBO	the total number of officer personnel, direct plus base operating, required to operate and provide base support to the aircraft system	10,17,19
DBT	the total number of personnel, direct plus base operating support, required to operate and provide base support to the aircraft system	10,17,18
DR	the direct requirements of manpower and operating funds represented by the total cost of Elements 1-5, 7-9, 11-13 (FY77$K)	14,16
E	the number of enlisted personnel per aircrew	2,5

EXHIBIT I-3 (cont'd.)

ALPHABETICAL LISTING OF VARIABLES

Variable	Definition	Cost Ele. Ref.
EA	the cost per aircraft of paying enlisted aircrewmen	2,10
EC	the number of combat command staff enlisted divided by the number of squadron aircraft	3,5,10
EH	the number of enlisted personnel in the holding account	19
EN	the number of engines mounted on the aircraft	13
EPR	enlisted pay rate (FY77$K) = $9.52	2,3,5,7,10,17, 18, 19
ERM	the unit cost of repairing an engine at the depot (FY77$K)	13
ERO	the unit cost of overhauling an engine at the depot (FY77$K)	13
ERT	the total cost of engine rework (FY77$K)	13,15
FAD	a fighter/attack dummy variable such that, FAD = 1 if the aircraft is a fighter or attack; FAD = 0 otherwise	4
FC_{100}	the cumulative average flyaway cost of the first 100 production aircraft (FY77$K)	21,22
FHY	the flying hours per year	4,8,9,11,13,20
GT	the gross take-off weight of the aircraft in thousands of pounds	4
HE	the number of health care enlisted personnel	18
HO	the number of health care officers necessary to support the weapon system	18
HOM	health care O&M funds (FY77$K)	18
HT	the total cost of health care	18
L	the airframe rework interval in months	12
LV	the number of aircraft procured	V
M	the annual cost of modifications (FY77$K)	21
MM	the cost per flying hour (FY77$K) of maintenance material	8
MMC	the annual cost (FY77$K) of maint. material	8, 15
MMHFH	the number of direct maintenance man-hours per flying hour as defined and reported by the 3-M system	11
MMHMO	the total maintenance manhours per month (direct maintenance manhours per flying hour (DMMH/FH) times flying hours per month (FM))	7,8,9,11,12,20
MO	the number of maintenance and operating personnel required per aircraft	5,7,10
MS	the maximum speed for level flight at altitude given in knots	4,8,9,11,12,20

EXHIBIT I-3 (cont'd.)

ALPHABETICAL LISTING OF VARIABLES

Variable	Definition	Cost Ele. Ref.
MTBF	the mean-time-between failures (hours) as reported by the 3-M system	20
NA	the number of operating aircraft in squadron	1,2,3,5,7
O	the number of officers per aircrew	1,5
OA	the cost per aircraft of paying officer aircrewmen	1,10
OC	the number of combat command staff officers divided by the number of squadron aircraft	3,5,10
ODM	the number of other deployed manpower per aircraft	5,10
ODMC	the cost of other deployed manpower	5
OH	the number of officer personnel in the holding account	19
OPR	officer pay rate (FY77$K = 22.14)	1,3,10,17,18,19
ORR	the overhaul/repair ratio, i.e., the number of a certain type engine overhauled in a year divided by the number repaired in a year	13
P	the pipeline factor (the percentage of aircraft in the depot maintenance process)	V
PCS	the annual cost (MPN funds) of PCS for weapon system direct and base operating personnel (FY77$K)	19
POL	the annual cost (FY77$K) of petroleum, oil and lubricants	4,15
POLF	the cost per flying hour of POL assuming a base price of $0.385 per gallon of JP-5	4
PS	the cost per flying hour (FY77$) of personnel support supplies	9
PSS	the annual cost (FY77$K) of personnel support supplies	9,15
REE	the number of recruiting and examining enlisted necessary to support the weapon system	19
REO	the number of recruiting and examining officers necessary to support the weapon system	19
REOM	recruiting and examining O&M funds (FY77$K)	19
RGSE	the annual cost of replenishment ground support equipment (FY77$K)	22
RS	the annual cost of procuring APN-6 replenishment spares to support the aircraft system (FY77$K)	15,20
RSF	the cost per flying hour of procuring APN-6 replenishment spares to support the aircraft system (FY77$K)	20
SDO	the annual cost of supply depot operations required to support a weapon system (FY77$K)	14,15
SDT	the annual cost of second destination transportation (FY77$K)	15

EXHIBIT I-3 (cont'd.)

ALPHABETICAL LISTING OF VARIABLES

Variable	Definition	Cost Ele. Ref.
SP	the total number of personnel in the squadron to be supported	5
T	the service life of the aircraft	V
TAOY	the total aircraft operating years	V
TDP	the number of total direct personnel (officers and enlisted) involved in operating and supporting the aircraft system. This is the sum of the personnel identified in Element 1 - Aircrew, Officer; Element 2 - Aircrew, Enlisted; Element 3 - Combat Command Staff; Element 5 - Other Deployed Manpower; and Element 7 - Aircraft Maintenance Manpower	10
TE	the number of enlisted personnel required for training duties	17
TET	the number of enlisted personnel in transit	19
TH	engine thrust in thousands of pounds	13
TO	the number of officer staff required for training duties	17
TOM	training O&M funds	17
TOT	the number of officers in transit	19
TPA	the total cost of personnel support (FY77$K)	19
TS	the annual cost of technical support (FY77$K)	17
TT	total training cost	17
UAR	the unit cost of an airframe rework (FY77$K)	12

EXHIBIT I-4

SUMMARIZATION OF POINTS OF CONTACT

	Code	Person	Telephone
o Deployed Unit Operations			
1. Aircrew (Officers)	Op-901M	Ms. Ruth	X-55038
2. Aircrew (Enlisted)	NCF-11	Mr. Kelso	X-79375
3. Combat Command Staff	Op-100E	LCDR Watts	X-42811
4. Aviation POL	Op-51C	Mr. Rymer	X-42128
5. Other Deployed Manpower			
6. Air TAD	PMA-270 (VAMOSC)	CAPT Dowd	X-27966
o Below Depot Maintenance			
7. Aircraft Maintenance Manpower	See Ele. 1-3		
8. Maintenance Material	Op-51C	Mr. Rymer	X-42178
	PMA-270	CAPT Dowd	X-27966
9. Personnel Support Supplies	Op-51C	Mr. Rymer	X-42178
	PMA-270	CAPT Dowd	X-27966
o Installation Support			
10. Base Operating Support	Op-901	Ms. Ruth	X-55038
o Depot Maintenance			
11. Component Rework	PMA-270 (VAMOSC)	CAPT Dowd	X-27966
12. Airframe Rework	NALC Code 210	Ms. Barsky	8-356-3952
13. Engine Rework	NALC Code 210	Ms. Barsky	8-356-3952
o Depot Supply			
14. Depot Supply Operations	Op-901M	Ms. Ruth	X-55038
15. Technical Support	Op-901M	Ms. Ruth	X-55038
o Second Destination Transportation			
16. Second Destination Transportation	Op-901M	Ms. Ruth	X-55038
o Personnel Support and Training			
17. Individual Training	Op-901M	Ms. Ruth	X-55038
18. Health Care	Op-901M	Ms. Ruth	X-55038
19. Personnel Activities	Op-901M	Ms. Ruth	X-55038
o Sustaining Investments			
20. Replenishment Spares	PMA-270 (VAMOSC)	CAPT Dowd	X-27966
21. Modifications	NALC Code 210	Ms. Barsky	8-356-3952
22. Replenishment Ground Sup. Equip.	PMA/NAVAIR	Depends on Program	
23. Training Ordnance	PMA-270 (VAMOSC)	CAPT Dowd	X-27966

larger than both of them combined. The total cost of training expendable stores in VAMOSC, which is known to omit the costs of both air-launched tactical missiles and sonobuoys, is still larger than engine rework. Therefore, it seems imperative that more attention be given to these two elements in future work.

II. INTRODUCTION

Purpose

The purpose of this report is two-fold. First, it is to document the updating (with Fiscal 1977 data) of the parametric model used for estimating Naval aircraft Operating and Support (O&S) costs; and, secondly, it is to transform the model documentation into a handbook or guide for use as a training aid for OP-96D aircraft cost analysts.

The updating process is necessary because the fleet is changing so rapidly that cost-estimating relationships (CER's) which are significantly older than one year are often obsolete. For example, in the past five years the Navy has used three primary concepts of depot airframe rework - each with significant cost implications. Also, the Navy is currently changing the maintenance concepts for most aircraft engines, which will have a significant impact on the estimation of engine costs. (This will be discussed in detail later in Section IV.) In addition to maintenance concepts, the data collection systems are also changing. The Visibility and Management of Operating and Support Costs (VAMOSC) system, which was used extensively in this update, is emerging as a useful, convenient source of operating and support (O&S) cost data.

The expansion of the documentation of the cost-estimating model to also serve as a handbook or guide for OP-96D aircraft cost analysts is a natural extension since much of the basic discussion can be generalized. The resulting report can be used as a training aid and it provides a stand-alone capability to generate a baseline estimate. It cannot, of course, replace the analyst's judgement which is always required in the process of weapon system cost analysis.

Background

The need to perform operating and support (O&S) cost analyses of developing systems stems primarily from the fact that O&S costs of present systems are becoming so large that they are draining funding away from weapon acquisition and weapon modernization programs. This simple fact, which was recognized some time back, is the reason the analysis of O&S costs has been incorporated into all aspects of the weapon system acquisition process. DoD Directive 5000.1, "Acquisition of Major Defense Systems," which is perhaps the primary DoD guidance on system acquisition, states very clearly that all costs, including O&S, shall be examined early enough in the program to affect the design of the system. Many other directives, instructions, etc., provide guidance or relate to the analysis of O&S costs. The reader is referred to the Op-96D Standard Operating Procedures or "Red Book," which provides a comprehensive overview of how the Navy manages both the fiscal and life cycles of weapon systems. It describes the Planning Programming Budgeting System (PPBS), the Five Year Defense Plan (FYDP) and the Division Coordinating Paper (DCP)/Navy Division Coordinating Paper (NDCP).

The Office of the Secretary of Defense (OSD) Cost Analysis Improvement Group (CAIG) has published or sponsored two guides on aircraft O&S cost analysis; the first[1] which was done by the CAIG was issued in May 1974. The second[2]

---

[1]Operating and Support Cost Development Guide for Aircraft Systems, Cost Analysis Improvement Group, May 1974.

[2]Aircraft Systems Operating and Support Costs: Guidelines for Analysis, Logistics Management Institute, March 1977.

which was done by a contractor was distributed informally. Both are good references, but the analyst must recognize that they are directed at the system manager, the person who has the ability to affect the design of the system, to make tradeoffs, and to invest more development money to obtain operational reliability and/or maintainability. The role of the analyst in Op-96D, who is preparing an independent estimate, is different. His estimate is, by necessity, cursory, since his manpower and time are constrained. The role of the independent analyst is also well documented in policy documents, notably in DoD Directive 5000.4,which clearly states the requirement for an independent parametric estimate to validate the Program Manager's (PM) estimate. Perhaps the best guidance on the independent estimate of weapon system costs is in the Op-96D "Red Book" mentioned earlier. This provides all the policy guidance, tells when an independent estimate is required and provides examples of previous analyses. This report is intended to "pick up" where the "Red Book" ends. It provides a general understanding of how Naval aircraft are operated and supported, an example of O&S costs, and a capability to estimate them for aircraft in development.

Definition of Relevant Costs

Before further discussion of cost estimation and analysis is given, it is important to define exactly what costs are to be estimated. Since the purpose of the DSARC and DNSARC (Department of the Navy Systems Acquisition Review Council) process is to better manage the process of weapon system acquisition, the costs shown in an analysis must be those that are

relevant to or affected by a DSARC/DNSARC decision, in other words, the variable costs. It is true that the identification of variable costs (versus fixed costs) is not always an easy matter. For instance, even in classical economic theory, the determination of variable costs is dependent upon the time frame being considered; and, in practical Navy applications, the distinction can often be extremely difficult. Therefore, the problem of determining the includable variable costs is not a matter of correctness, but one of understanding and agreement. The CAIG has issued guidelines in this area which are clear and precise and Section IV of this report attempts to adapt those guidelines to the situation of the Navy in a similarly clear and precise way. Costs which are included in an O&S analysis should be specifically defined in one of the twenty-three cost elements in Section IV. It should be noted that the cost element structure and definitions are included as Appendix A for easy reference. This appendix can be excerpted and used as preliminary guidance or reference for a Project Manager or anyone else attempting to perform an aircraft O&S analysis.

Report Organization

This report is organized into five sections with six appendices. Section I is an Executive Summary which provides an overview of the report, including the cost element structure, a summary of the CER's, an alphabetical listing of variables and their definitions, and a list of points of contact. Section II is the Introduction, which consists of a discussion of the purpose of the report, the background, the definition of relevant costs, and a summary of the report organization. Section III contains the cost element

structure which is the basis for this model, and a discussion of its past and future evolution. Section IV contains a complete treatment of each of the cost elements consisting of:

a. a definition of the cost element;

b. a discussion of the data, its availability and accuracy and a point of contact for future reference;

c. a cost-estimating relationship with regression statistics and data base;

d. alternative CER's; and,

e. an example calculation.

In the process of this update of the model, a thorough statistical analysis was made of all the data. A CER was picked for each element and included in the automated version of the model; but since many acceptable CER's were developed, an alternative one is being included as part of the narrative in Section IV. These CER's are sometimes based on a slightly different data base, or use different explanatory variables and in the future may be considered preferable to the primary CER's for a particular analysis. Section V discusses how to compute Life Cycle O&S costs from the average annual O&S costs computed in Section IV. Appendix A contains the Navy Cost Element Structure used in this report, including definitions. This information is taken from Section IV and summarized in the appendix for easy reference. Appendix B contains the corresponding cost-element structure and definitions issued as guidance by the CAIG. Appendix C contains O&S data. Appendices D, E, and F pertain to the automated model described in this report. Appendix D contains the user instructions; Appendix E contains sample runs; and, Appendix F contains a copy of the program code.

III. COST ELEMENT STRUCTURE

The cost element structure (CES) used in this report is the same as was used in the previous edition of this model.[1] It is contained in Exhibit III-1 in this section and in Appendix A. Appendix A, which also contains a list of definitions for each cost element, can be excerpted from the report to serve as documentation of an O&S analysis, or as initial guidance for a Navy Program Manager or Study Director who is preparing an O&S analysis for a Naval aircraft system.

The CES is based on Office of the Secretary of Defense (OSD) Cost Analysis Improvement Group (CAIG) guidance contained in an August 31, 1977 Memorandum. The memorandum, the recommended aircraft CES and associated definitions are contained in Appendix B. The Navy CES follows very closely the CAIG preferred one, but contains some minor changes to reflect the unique aspects of Navy organization, mission, maintenance philosophies and accounting systems. It does, however, capture exactly those costs defined in the memorandum, as well as being comparable at the major heading level.

---

[1]See "Naval Aircraft Operating and Support Cost Model - FY76 Revision," ASC R-116, March 1978.

EXHIBIT III-1

NAVY COST ELEMENT STRUCTURE

- Deployed Unit Operations
  1. Aircrew (Officers)
  2. Aircrew (Enlisted)
  3. Combat Command Staff
  4. Aviation POL
  5. Other Deployed Manpower
  6. Air TAD
- Below Depot Maintenance
  7. Aircraft Maintenance Manpower
  8. Maintenance Material
  9. Personnel Support Supplies
- Installation Support
  10. Base Operating Support
- Depot Maintenance
  11. Component Rework
  12. Airframe Rework
  13. Engine Rework
- Depot Supply
  14. Depot Supply Operations
  15. Technical Support
- Second Destination Transportation
  16. Second Destination Transportation
- Personnel Support and Training
  17. Individual Training
  18. Health Care
  19. Personnel Activities
- Sustaining Investments
  20. Replenishment Spares
  21. Modifications
  22. Replenishment Ground Support Equipment
  23. Training Ordnance

IV. COST-ESTIMATING RELATIONSHIPS AND DISCUSSION

This section contains a definition, discussion, a primary cost-estimating relationship (CER), secondary cost-estimating relationship (if any), and an example calculation for each of the twenty-three cost elements contained in Table III-1. Costs are based on FY77 data and therefore are in FY77 dollars unless otherwise noted. The primary CER's are the ones contained in the automated model described in Appendices E-G, but may be replaced with others, if the reader desires to do so. Each CER is described by t statistics (shown in parentheses under the appropriate coefficients), adjusted coefficient of determination ($\bar{R}^2$), the sample size (N), the F statistic and the standard error of the estimate (S.E.E.). The complete data base is also given for each parametric CER. This serves two purposes. First, it provides the reader with a better understanding of what was done and facilitates future analysis. Second, it gives the reader the ability to determine the relevant range of the CER by being able to examine the range of the variables in the data base. This enables the analyst to make a judgement regarding the extent to which he can extrapolate.

All CER's, definitions and computed examples are for the cost of a single operating aircraft or unit of equipment (UE) operated in a squadron. To obtain the squadron cost or force cost, the analyst simply has to multiply the cost per UE by the number of operating aircraft. Further discussion of computing Life Cycle O&S costs is contained in Section V.

1. AIRCREW (OFFICER)

1a. Definition - This is the cost of paying officer personnel who operate the squadron aircraft. Although all pilots perform other duties in the squadron, such as maintenance supervision or squadron staff functions, their primary duty is considered to be that of aircrew and their full cost is shown in this element.

1b. Discussion - Direct manpower costs are found in this Element, Element 2 - Aircrew (Enlisted), Element 3 - Combat Command Staff, Element 5 - Other Deployed Manpower, and Element 7 - Aircraft Maintenance Manpower. In addition, indirect manpower costs are found in Element 10 - Base Operating Support, Element 17 - Individual Training, Element 18 - Health Care, and Element 19 - Personnel Activities. Therefore, to avoid repetition, the generic issues of costing manpower are discussed only in this section although they apply to all the aforementioned elements.

Determining the cost of manpower has been a subject of much interest and study recently.[1] To mention only a few of the problems; Naval pay varies not only with rank, but also length of service. Allowances vary with type of duty, dependency status and many other factors. Reenlistment bonuses of varying amounts are paid to personnel whose skills are in short supply. Finally, to fill a certain number of productive billets, the Navy must recruit and train an excess number of personnel in order to account for those who drop out or are weeded out. All of the above are legitimate costs

---

[1]See Military Manpower Versus Hardware Procurement Study (HARDMAN), Final Report, 25 October 1977.

of a weapon system and the treatment of each source of variation may or may not influence a weapon system acquisition decision. For instance, if a weapon system requires a certain kind of aircraft maintenance mechanic, his cost may be computed at the FY77 Five Year Defense Plan (FYDP) average rate of $9,517. If, however, that specific enlisted rating is difficult for the Navy to recruit, train and, most importantly, retain, then the manpower cost of this particular decision could be far greater than the average rate (including the support tail) would indicate.[2]

Currently, there are several sources of military personnel cost data. None of them address the type of problem mentioned above, but they do give the analyst a choice concerning level of detail. The most generalized source of personnel costs is the Navy Resource Model (NARM) which contains the average rate for officer and enlisted personnel contained in the FYDP. The NARM also carries this one step further and those results can be found in the Navy Program Factors Manual.

The Manual, which was designed for use in planning and programming to estimate the dollar and manpower resources required to operate and support a single ship or aircraft, estimates direct military personnel costs by multiplying the manpower allowances (generally consistent with the applicable Manpower Authorization Document issued by OPNAV-100D) by a Military Personnel, Navy (MPN) appropriation dollar factor (one for officers and one for enlisted). This factor, which includes basic, incentive and special pay allowances, and

---

[2] For more detail on this topic see Naval Manpower Costs and Cost Models: An Evaluative Study, Final Report, ASC R-119, Administrative Sciences Corporation, August 1978.

expenses, is developed by a sub-model known as QUIKPAY.[3] The figure resulting from the multiplication of the MPN factor with the number of authorized billets is multiplied by a weighting factor, supplied by Bureau of Personnel (BUPERS), which varies around 1.0. This weighting factor can be thought of as a correction factor to adjust for the difference between the Navy average cost and the particular program element average cost. In other words, if the FYDP average for enlisted personnel is 9,517(FY77$) and the weighting factor for F-14 squadrons - program element 24144N is 1.024, the average cost for enlisted personnel in an F-14 squadron is $9,745 (FY77$). For further information regarding the NARM or the Factors Manual, contact Ms. Ruth (X-55038).

If information describing not only the aggregate number of military personnel but also the grades of those personnel is available, then the Navy Composite Standard Rates (CSR) offers a measure of refinement not available in the NARM. Composite Standard Rates for costing all military personnel are contained in Section 252, DoD Accounting Guidance Handbook (DoD 722-0.9-H). These rates are essentially averages for all personnel in a grade. They include basic, incentive and special pay, allowances (e.g., quarters, subsistence, separation, uniform), and expenses (e.g., FICA, bonuses, life insurance). Exhibit IV-1 shows the CSR for FY77. Rates for FY78 are also available and are contained in Table C-1 of Appendix C. Multiplying the number of military personnel in each pay grade by the corresponding CSR will produce the equivalent cost estimate as that of the NARM. The CSR for the Navy are distributed by NAVCOMPT-NCF-11 and are revised annually.

---

[3]For more information on QUICKPAY see Center for Naval Analyses report, User's Guide to the QUIKPAY Model, CRC 272, September 1975.

EXHIBIT IV-1

NAVY COMPOSITE STANDARD MILITARY RATE TABLE
(Effective 1 October 1976)

Pay Grade	Rank or Grade	Hourly Rate	Daily Rate	Monthly Rate	Annual Rate
O-10	Admiral	26.15	209.19	4,532	54,389
O-9	Vice Admiral	23.29	186.29	4,036	48,436
O-8	Rear Admiral (Upper Half)	22.11	176.88	3,833	45,990
O-7	Rear Admiral (Lower Half)	18.95	151.58	3,284	39,411
O-6	Captain	17.39	139.14	3,015	36,176
O-5	Commander	14.48	115.84	2,510	30,118
O-4	Lieutenant Commander	12.17	97.35	2,109	25,312
O-3	Lieutenant	10.84	86.71	1,879	22,544
O-2	Lieutenant Junior Grade	8.07	64.56	1,399	16,786
O-1	Ensign	5.80	46.40	1,005	12,063
W-4	Commissioned Warrant Office	10.72	85.78	1,859	22,302
W-3	Commissioned Warrant Office	9.15	73.21	1,586	19,035
W-2	Commissioned Warrant Office	7.83	62.62	1,357	16,279
W-1	Warrant Officer	6.86	54.90	1,189	14,273
E-9	Master Chief Petty Officer	9.34	74.75	1,620	19,436
E-8	Senior Chief Petty Officer	8.12	64.98	1,408	16,894
E-7	Chief Petty Officer	7.07	56.52	1,225	14,696
E-6	Petty Officer First Class	6.03	48.27	1,046	12,550
E-5	Petty Officer Second Class	5.00	39.98	866	10,395
E-4	Petty Officer Third Class	4.15	33.17	719	8,624
E-3	Seaman	3.67	29.37	636	7,635
E-2	Apprentice	3.35	26.79	580	6,965
E-1	Recruit	3.02	24.15	523	6,280
	Midshipmen	2.62	20.96	454	5,450

Information concerning these revisions can be obtained from Mr. E. Kelso (X-79375) NCF-11.

There are several ways of determining the specific numbers and grade of each squadron member if the analyst decides to use CSR. A detailed estimate of the squadron personnel requirements is usually drawn up relatively early in the life of the program by the Naval Air Logistic Center (NALC). This can be used as is or with any adjustments deemed reasonable by the analyst. A second method is to look at a Manpower Authorization Document for the aircraft which is being replaced. Again, this can be used as is or adjusted by the analyst. Manpower Authorization Documents for fleet aircraft can be obtained from LCDR Watts (X-42811) Op100E. Finally, this report contains a series of equations which can be used to estimate the required personnel. These equations which are discussed in detail in subsequent sections are "driven" primarily by maintainability measured by the direct maintenance manhours per month (DMMH/MO or DMMH/FH x FH/MO).

The Visibility and Management of Support Costs (VAMOSC) Management Information System, also known as NALCOMIS-O&S, uses the Composite Standard Rates as the basis for its military personnel costs. In the Total Support System (TSS) visibility extends only to the total cost for the type/model/series aircraft which usually includes several squadrons. This is an interesting figure to analyze because it gives a measure of the gap between authorized manning and on-board manning. On-board manning is usually lower since the Navy is constrained from manning fully to the authorized level. It also varies because billets are often filled with personnel whose rank is different from the authorized rank. The VAMOSC Maintenance Support System (MSS)

does provide the labor cost for direct maintenance on the aircraft and these costs are identified to the four digit work unit code (WUC) level. Labor costs are computed with a rate designed to capture the unproductive time of the mechanic, but no provision is made for supervisory or administrative personnel. Therefore, the VAMOSC-MSS can be used for specific subsystem analysis but not to derive a total squadron manpower cost.[4]

1c. Cost-Estimating Relationship

$$OA = O \times CF \times OPR$$

where,

OA = the cost per aircraft of paying officer aircrewmen

O = the number of officers per aircrew

CF = the crew factor or the number of aircrew contained in the squadron divided by the number of operating aircraft

OPR = the FYDP average officer pay rate (FY77$K = 22.14)

Note: The variable OPR can be adjusted by the weighting factor found in the NARM for the relevant program element if so desired.

1d. Alternative CER

$$OA = \Sigma(O_i \times CSR_i)/NA$$

where,

OA = the cost per aircraft of paying officer aircrewmen

O_i = the number of officer aircrewmen in the squadron in the i^{th} pay grade

CSR_i = the composite standard rate of pay for the i^{th} pay grade

NA = the number of operating aircraft in squadron

---

[4]For more information on VAMOSC see NALCOMIS-O&S/VAMOSC-AIR System Description Manual, VolumesI & II, December 1977.

1e. Example Calculation

For the purpose of this report O&S costs will be calculated for a hypothetical light attack aircraft. In addition to the primary CER, the use of the CSR will be demonstrated. Because of space limitations, the CSR will not be demonstrated for the rest of the manpower elements.

Using the primary CER:

O = 1

CF = 1.42

OPR = 22.14 (FY77$K)

OA = 1 x 1.42 x 22.14

OA = 31.4 (FY77$K)

Using the CSR:

Grade	#Officers	CSR (FY77$K)	Cost (FY77$K)
0-5	2	30.1	60.2
0-4	4	25.3	101.2
0-3	3	22.5	67.5
0-2	8	16.8	134.4
			363.3

NA = 12

OA = 363.3/12 = 30.3 (FY77$K)

2. AIRCREW (ENLISTED)

2a. Definition - This is the cost of paying enlisted personnel who perform as crewmembers for the aircraft.

2b. Discussion - Enlisted crewmembers are costed in this element, although they perform other duties as well.

2c. Cost-Estimating Relationship:

$$EA = E \times CF \times EPR$$

where,

EA = the cost per aircraft of paying enlisted aircrewmen

E = the number of enlisted personnel per aircrew

CF = the crew factor

EPR = the enlisted pay rate (FY77$K = 9.52)

2d. Alternative CER

$$EA = \Sigma(E_i \times CSR_i)/NA$$

where,

EA = the cost per aircraft of paying enlisted aircrewmen

E_i = the number of enlisted aircrewmen in the squadron in the i^{th} pay grade

CSR_i = the composite standard rate for the i^{th} pay grade

NA = the number of aircraft

2e. Example Calculation

E = 0

CF = 1.42

EPR = 9.52 (FY77$K)

$$EA = 0 \times 1.42 \times 9.52$$

$$EA = 0$$

Since the light attack aircraft chosen for this example has no enlisted aircrewmen, the estimate of this cost is zero. For aircraft which do require enlisted aircrewmen, such as the P-3, this cost element would not be zero.

3. COMBAT COMMAND STAFF

3a. Definition - This element represents the pay of manpower necessary for management and supervision of squadron operations.

3b. Discussion - Included in this category are:

- the Air Wing Commander and his staff allocated equally to each of the wing's aircraft deployed on the carrier,
- the squadron Administration Department[1],
- the squadron Operations Department[1],
- the squadron Executive and Executive Assistance Department[1],
- the squadron Safety Department[1],
- the squadron Photo Department[1] (if any), and
- any other personnel whose primary function places them in this cost element.

Exhibit IV-2 contains a typical squadron organization chart which can be used for reference in identifying the various manpower costs. Tables C-2 and C-3 of Appendix C contain the Manpower Authorization Documents for officer and enlisted (respectively) members of the Air Wing Commander's staff. If the analyst has no other information or reason to believe that the weapon system under review will impact the air wing staff, then the costs of the billets in these two tables can be allocated to the squadron aircraft.

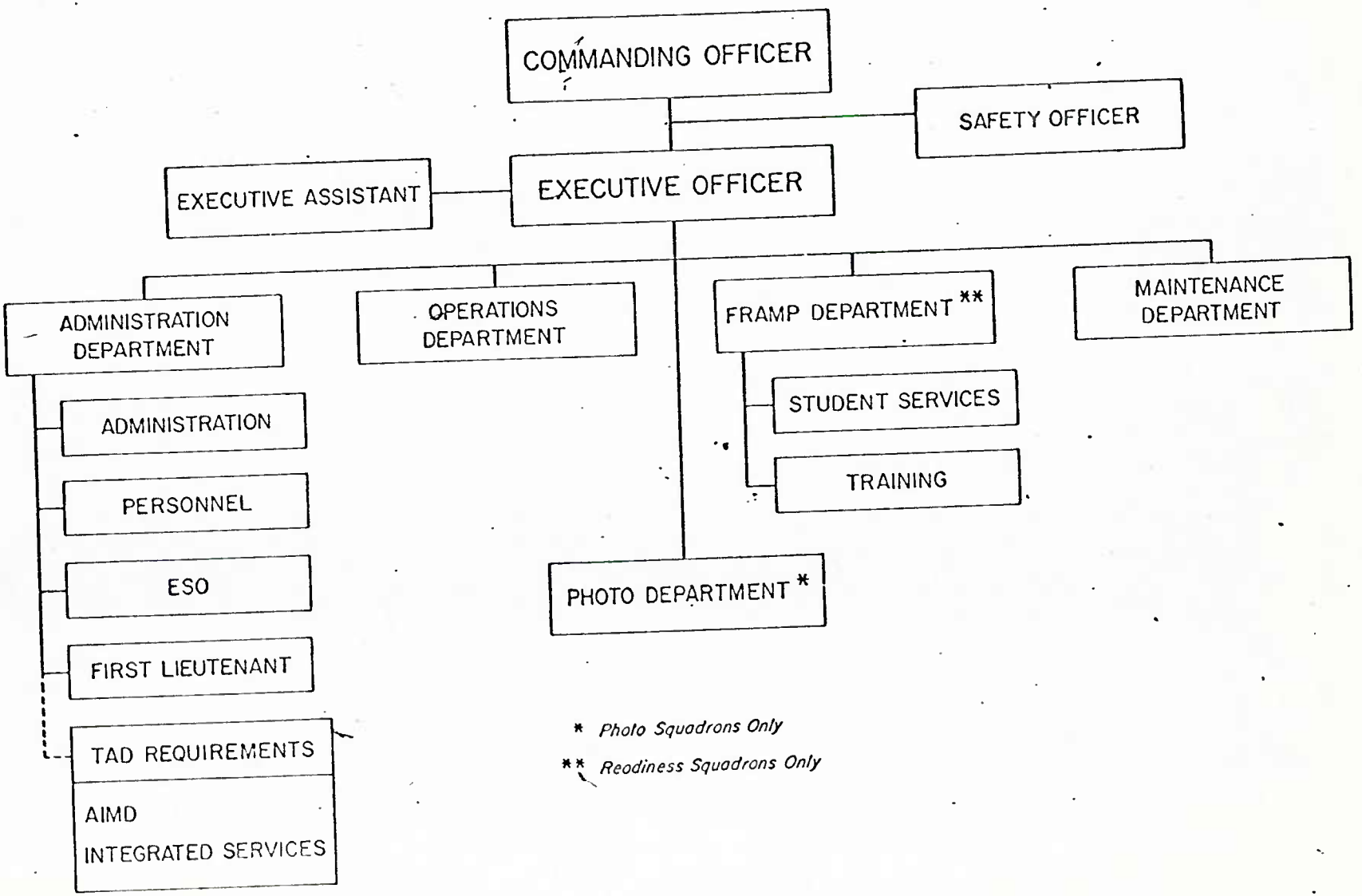
Practically speaking, the Navy usually excludes all non-squadron personnel from the direct costs of the aircraft. The analyst must determine the ground rules being used for each particular weapon system review.

---

[1]Aircrew members are excluded.

EXHIBIT IV-2

SQUADRON ORGANIZATION



3c. Cost-Estimating Relationship

$$CCS = (OC \times OPR) + (EC \times EPR)$$

where,

CCS = the cost of combat command staff manpower

OC = the number of combat command staff officers divided by the number of squadron aircraft

OPR = the officers pay rate (FY77$K = 22.14)

EC = the number of combat command staff enlisted divided by the number of squadron aircraft

EPR = the enlisted pay rate (FY77$K = 9.52)

3d. Alternative CER

$$CCS = \frac{\Sigma\left[(OC_i \times CSR_i) + (EC_i \times CSR_i)\right]}{NA}$$

where,

CCS = the cost of combat command staff manpower

OC_i = the number of combat command staff officers in the i^{th} pay grade

CSR_i = the composite standard rate for an officer in the i^{th} pay grade

EC_i = the number of combat command staff enlisted in the i^{th} pay grade

CSR_i = the composite standard rate for an enlisted person in the i^{th} pay grade

NA = the number of aircraft in the squadron

3e. Example Calculation

Assume the following personnel per aircraft:

	Officer	Enlisted	
Wing Staff	0.10	0.07	(10 off./100A/C; 7 enl./100A/C)
Executive Dept.	0.08	0.05	(1 off./12A/C; 6 enl./12A/C)
Administration Dept.	0.00	0.17	(0 off./12A/C; 2 enl./12A/C)
Operations Dept.	0.00	0.33	(0 off./12A/C; 2 enl./12A/C)
Safety Dept.	0.00	0.08	(0 off./12A/C; 1 enl./12A/C)
	0.18	1.15	

(Aircrew members are excluded)

$$CCS = (0.18 \times 22.14) + (1.15 \times 9.52)$$

$$= 14.9 \text{ (FY77\$K)}$$

4. AVIATION POL

4a. Definition - Aviation POL is the cost of petroleum, oil and lubricants (including fuel additives) consumed by aircraft in flight operations and maintenance.

4b. Discussion - OPNAV Instruction 7310.1C dated May 17, 1976, outlines the general reporting requirements for monitoring of funds related to the Flying Hour Program which, among other things, includes POL. The custodial commands, Commander, Naval Air Force, U.S. Atlantic Fleet; Commander, Naval Air Force, U.S. Pacific Fleet; Commander, Naval Air Reserve; and, Chief of Naval Education and Training, are responsible for collecting, processing and forwarding the required monthly data which is submitted via the Automatic Digital Network (AUTODIN) to the cognizant accounting activities. It is then forwarded to OPNAV (OP-51C and OP-511E). This data provides an accurate reading of flying hours and POL costs by type/model/series aircraft. OP-51C also transmits a summary tape to the NALCOMIS O&S/VAMOSC-AIR project office for incorporation into VAMOSC-Total Support System. The VAMOSC-TSS therefore provides what is probably the most accessible source of data, although if one wishes to examine the data in any detail, the OP-51C reports must be obtained. To obtain more information on the VAMOSC system, contact CAPT Dowd, PMA270 (X-27966). For more information on the OP-51C data and the Flying Hour Cost Report, contact Mr. Rymer, OP-51C (X-42128).

4c. Cost-Estimating Relationship

$$POL = \frac{POLF \times FHY}{1000}$$

$$POLF = \underset{(3.63)}{0.2987(GT)^{0.4403}} \times \underset{(7.82)}{(MS)^{0.7986}}$$

$\bar{R}^2$ = 0.83

N = 15

F = 31.70

S.E.E. = 0.21

where,

POL = the annual cost (FY77$K) of petroleum, oil and lubricants

POLF = the cost per flying hour of POL assuming a base price of $0.385 per gallon of JP-5[1]

FHY = the flying hours per year

GT = the gross take-off weight of the aircraft in thousands of pounds

MS = the maximum speed for level flight at altitude given in knots

DATA BASE

Aircraft	POLF (FY77$)	GT (thous. of lbs.)	MS (knots)
A-4M	226.2	24.5	515
RA-5C	525.8	80.0	1,164
EA-6B	383.6	58.6	538
A-6E	399.8	58.6	563
A-7E	242.4	42.1	606
C-2A	176.9	54.9	306
C-130F	278.1	155.0	326
E-2B	151.4	51.8	320
E2C	148.2	51.8	320
F-4J	566.2	54.7	1,280
F-4N	574.7	54.7	1,280
RF-8G	282.7	30.0	1,174
P-3C	281.8	134.9	409
S-3A	150.4	42.5	432
F-14A	469.7	42.1	1,342

[1]Current planning figures for FY79 are $0.420/gal for JP-4, $0.441/gal for JP-5 and $0.559/gal for aviation gas.

A note about the POL CER development methodology is in order at this point. In the past, the variables gross take-off weight (GT) and maximum speed (MS) have been good estimators of POL/FH. Since the purpose of this model is to provide a generalized estimating capability, the data bases have been designed to include a diversity of aircraft types. Such is the case with the POL data base which includes everything from relatively slow, propeller-driven aircraft to high performance, afterburning fighters and finally the more efficient turbofan-powered aircraft. The question has arisen, "why not identify or treat these engine features specifically in the CER?" The answer is somewhat equivocal. They could be incorporated in the CER's but whether or not they improve the prediction capability is questionable.

In order to investigate this, three dummy variables were added to the data base in section 4c.; one to indicate afterburning engines, one to indicate propeller engines, and one to indicate turbofan engines. Only the last variable, indicating a turbofan engine, was significant. The equation is as follows:

4d. Alternative CER

$$POL = \frac{POLF \times FHY}{1000}$$

$$POLF = \underset{}{116.1898} + \underset{(5.65)}{0.3174MS} - \underset{(-1.45)}{80.4970FD}$$

$$\bar{R}^2 = 0.69$$

$$N = 15$$

$$F = 16.30$$

$$S.E.E. = 85.63$$

where,

POL = the annual cost (FY77$K) of petroleum, oil and lubricants

POLF = the cost per flying hour of POL assuming a base price of $0.386 per gallon of JP-5

FHY = the flying hours per year

MS = the maximum speed for level flight at altitude given in knots

FD = a dummy variable such that

FD = 1 if the aircraft engine is a fan

FD = 0 otherwise

DATA BASE

A/C	POLF (FY77$)	MS (knots)	FD
A-4M	226.2	515	0
RA-5C	525.8	1,164	0
EA-6B	383.6	538	0
A-6E	399.8	563	0
A-7E	242.4	606	1
C-2A	176.9	306	0
C-130F	278.1	326	0
E-2B	151.4	320	0
E-2C	148.2	320	0
F-4J	566.2	1,280	0
F-4N	574.7	1,280	0
RF-8G	282.7	1,175	0
F-14A	469.7	1,342	1
P-3C	281.4	409	0
S=3A	150.4	433	1

As can be seen, the regression statistics do not indicate as strong a relationship as was present in section 4c. and the t statistic for the turbofan dummy variable is only marginally significant. A second alternative CER was developed by removing all of the propellar aircraft from the data base and again indicating the turbofan powered aircraft with a dummy variable. The equation is as follows:

Second Alternative CER

$$POL = \frac{POLF \times FHY}{1000}$$

$$POLF = \underset{}{-33.9341} + \underset{(2.87)}{4.4319GT} + \underset{(3.91)}{0.2450MS} - \underset{(-1.19)}{60.1370FD}$$

$$\bar{R}^2 = 0.79$$

$$N = 10$$

$$F = 12.10$$

$$S.E.E. = 69.95$$

where,

POL = the annual cost (FY77$K) of petroleum, oil and lubricants

POLF = the cost per flying hour of POL assuming a base price of $0.385 per gallon of JP-5

FHY = the flying hours per year

GT = the gross take-off weight of the aircraft in thousands of pounds

MS = the maximum speed for level flight at altitude given in knots

FD = a dummy variable such that

FD = 1 if the aircraft engine is a fan

FD = 0 otherwise

DATA BASE

A/C	POLF (FY77$)	GT (thous. of lbs.)	MS (knots)	FD
A-4M	226.2	24.5	515	0
RA-5C	525.8	80.0	1,164	0
EA-6B	383.6	58.6	538	0
A-6E	399.8	58.6	563	0
A-7E	242.4	42.1	606	0
F-4J	566.2	54.7	1,280	0
F-4N	574.7	54.7	1,280	0
RF-8G	282.7	30.0	1,174	0
S-3A	150.4	42.5	432	1
F-14A	469.7	42.1	1,342	1

As can be seen in the regression statistics, again, there is no significant improvement in the relationship even after the propeller aircraft are removed. In summary, the identification of the type of engine has little or no effect on the predictive power of the CER. All equations, however are good CER's and the analyst can use any one of them.

4e. Example Calculation

Assume: GT = 45 (thous. of lbs.)

MS = 600 (knots)

FHY = 360

$$POLF = 0.2987(45)^{0.4403} \times (600)^{0.7986}$$

$$= 264.11$$

$$POL = (264.11 \times 360)/1000$$

$$= 95.1 \text{ (FY77\$K)}$$

5. OTHER DEPLOYED MANPOWER

5a. Definition - This is the cost of all squadron personnel who are of a support or administrative nature. It is essentially the remainder of the squadron personnel who are not costed in Elements 1. Aircrew (Officers), 2. Aircrew (Enlisted), 3. Combat Command Staff, or 7. Aircraft Maintenance Manpower.

5b. Discussion - Other Deployed Manpower consists primarily of the Integrated Services section (see Exhibit IV-2) of the squadron. The purpose of this section is to provide the commissarymen, food servicemen, laundrymen, stewards, supply clerks, pay clerks, medical technicians and other miscellaneous personnel to the support activities of the ship or air station to meet the incremental support requirements generated by the squadron.

5c. Cost-Estimating Relationship - Since the number of personnel required is principally determined by the total number in the squadron, this cost can be calculated with the following equation:

$$ODMC = ODM \times EPR$$

$$ODM = \underset{(26.04)}{-0.5027 + 0.2231 \times (SP)^{0.5}}$$

$$\bar{R}^2 = 0.98$$

$$N = 13$$

$$F = 678.00$$

$$S.E.E. = 2.83$$

where,

ODMC = the cost of other deployed manpower

ODM = the number of other deployed manpower per aircraft

EPR = the enlisted pay rate (FY77$K = 9.52)

SP = the total number of personnel in the squadron to be supported

SP can be computed with the following equation:

$$SP = ((O+E) \times CF + OC + EC + MO) \times NA$$

where,

O = the number of officers per aircrew (from Element 1)

E = the number of enlisted per aircrew (from Element 2)

CF = the crew factor (from Element 1)

OC = the number of combat command staff officers per aircraft (from Element 3)

EC = the number of combat command staff enlisted per aircraft (from Element 3)

MO = the number of maintenance and operating personnel per aircraft (from Element 7)

NA = the number of aircraft per squadron

DATA BASE

SP	Other Deployed Manpower
0	0
25	4
50	10
75	14
100	18
150	27
200	33
250	38
300	43
400	49
500	54
600	59
700	64

5d. Alternative CER - If the number and grade of the authorized billets is known the following CER can be used:

$$ODMC = \Sigma(E_i \times CSR_i)/NA$$

where,

ODMC = the cost of other deployed manpower

E_i = the number of enlisted personnel in the i^{th} pay grade

CSR_i = the composite standard rate of pay for the i^{th} pay grade

NA = the number of aircraft per squadron

5e. Example Calculation

Assume:

O = 1 (from Element 1)

E = 0 (from Element 2)

CF = 1.42 (from Element 1)

OC = 0.18 (from Element 3)

EC = 1.15 (from Element 3)

MO = 12.47 (computed in Element 7)

NA = 12 (from Element 1)

$$SP = ((1) \times 1.42 + 0.18 + 1.15 + 12.47) \times 12$$

$$= 15.22 \times 12$$

$$= 183$$

$$ODM = -0.5027 + 0.2231(183)^{0.5}$$

$$= 2.51$$

$$ODMC = 2.51 \times 9.52$$

$$= 23.9 \text{ (FY77\$K)}$$

6. AIR TEMPORARY ADDITIONAL DUTY

6a. Definition - Air Temporary Additional Duty (TAD) is the cost of travel, lodging and incidental expenses incurred so that squadron personnel can receive training (usually maintenance-related).

6b. Discussion - This cost, which is usually small, is dependent on the size of the squadron, especially the Maintenance Department, and the complexity of the aircraft. The NARM has representative costs for TAD, but they are not particularly accurate. The VAMOSC-TSS is currently the best historical source for these costs. VAMOSC gets these data annually from the Navy Cost Information System (NCIS).

6c. Cost-Estimating Relationship - Exhibit IV-3 provides a representative sample of Air TAD (AT) Costs for FY1977. Estimates can be obtained by analogy using current aircraft or by scaling.

6d. Example Calculation

Assume the aircraft being estimated will have the same TAD requirements as the A-7E:

AT = 2.3 (FY77$K) from Exhibit IV-3

Exhibit IV-3

Representative Air TAD Costs for FY77
($ in thous.)

Aircraft	TAD Costs per A/C	Aircraft	TAD Costs per A/C
A-3B	0	F-4B	0
EA-3B	28.9	F-4J	2.3
A-4E	0.5	F-4N	2.0
TA-4F	3.8	RF-8G	1.0
A-4F	0.2	F-14A	1.6
A-4M	1.9	F-5E	1.3
TA-4J	0.3	UH-1L	0
RA-5C	5.17	UH-1N	0.1
A-6A	2.2	SH-2D/F	1.4
EA-6B	3.3	SH-3A	1.0
KA-6D	2.6	CH-46F	4.0
A-6E	2.5	CH-53D	0.7
A-7A	1.6	RH-53D	8.2
A-7E	2.3	P-3B	26.3
EC-121K	0	P-3C	22.9
C-130F	13.6	US-2A/B	0.1
C-1A	3.3	S-2E	0
C-2A	7.8	S-3A	2.3
E-1B	0.3	T-2C	0
E-2B	2.5	T-34B	0
E-2C	5.5	OV-10A	0.7
		AV-8A	1.0

Source: VAMOSC-TSS, FY77

7. AIRCRAFT MAINTENANCE MANPOWER

7a. Definition - This element consists of the cost of all manpower necessary to support the total preventive and corrective maintenance actions performed on the aircraft and its installed systems and equipments. This includes the squadron personnel who are assigned TAD to the Aircraft Intermediate Maintenance Department.

7b. Discussion - This cost consists of the personnel in the Maintenance Department and the AIMD portion of the TAD requirements (see Exhibit IV-2). Currently, there is no known data source which reports historical costs for this subset of the squadron contingent. The cost can be estimated, however, by identifying the appropriate personnel shown on an authorization document.

7c. Cost-Estimating Relationship - This cost can also be estimated with relative accuracy using the estimated maintainability (DMMH/FH) of the aircraft and the following equation:

$$AMM = MO \times EPR$$

$$MO = \underset{(11.81)}{(1.670 + 0.018MMHMO)}$$

$\bar{R}^2 = 0.933$

$N = 11$

$F = 139$

$S.E.E. = 2.23$

where,

AMM = the cost of aircraft maintenance manpower

MO = the number of maintenance and operating personnel required

EPR = the enlisted pay rate (FY77$K = 9.52)

MMHMO = the total maintenance manhours per month (direct maintenance manhours per flying hour (DDMH/FH) times flying hours per month (FM))

DATA BASE

Aircraft	MO	MMHMO[1]
A-4F	10.77	462
RA-6C	37.35	1,911
A-6A	19.98	1,084
A-7E	16.06	734
E-1B	12.25	512
E-2B	27.50	1,339
F-4J	18.88	1,981
F-8J	13.14	780
S-2E	11.43	346
P-3B	16.77	994
C-1A	7.32	468

It should be noted that the MO data prevsiously quoted is taken from OPNAVINST C5311.3b which is dated April 12, 1971 and is obviously outdated. In fact, the concept of the MO factor is one which is no longer officially used in the Navy. However, the concept remains the same and each Navy squadron has a specific number of personnel concerned with the maintenance and operation of the aircraft whether they are referred to in terms of an MO factor or otherwise. This factor could have been updated, but was not, for two reasons. First, it would have been too time consuming for the scope of this work; and secondly, the current equation has proved accurate in a number of recent analyses and is believed to still be valid. Perhaps, at a later time, when the resources are available, this equation can be reconfirmed or revised.

[1]Based on FY76 data.

7d. Alternative CER - If the number and grades of the authorized billets are known, the following CER can be used:

$$AMM = \Sigma(E_i \times CSR_i)/NA$$

where,

AMM = the cost of aircraft maintenance manpower

E_i = the number of enlisted personnel in the i^{th} pay grade

CSR_i = the composite standard rate of pay for the i^{th} pay grade

NA = the number of aircraft per squadron

7e. Example Calculation

Assume MMHMO = 600

$$MO = 1.670 + 0.018(600)$$

$$= 12.47$$

$$AMM = 12.47 \times 9.52$$

$$= 118.7 \text{ (FY77\$K)}$$

8. MAINTENANCE MATERIAL

8a. Definition - This is the cost of all maintenance supplies, whether acquired by the Navy Stock Fund (NSF) or any other method of funded purchase, which are not repqired for reuse. The costs are incurred at both the organizational and intermediate levels.

8b. Discussion - OPNAV Instruction 7310.1C, "Report of Flying Hour Costs and Related Flying Hours," requires all Naval and Marine Corp aviation force activities to report flight operation and aviation fleet maintenance transactions chargeable to a fleet operating budget. The Requisition /OPTAR Log (NavCompt form 2155) is the basis for recording and accumulating transactions applicable to each aircraft type/model/series. Included among the items that are authorized for expenditure against aviation maintenance funds are:

- Aeronautical repair parts
- Hand tools
- Greases, lubricants, hydraulic fluids
- Cleaning gear (e.g. rags, solvent, etc. used in cleaning or corrosion control of aircraft and related equipment
- Bases
- Safety shoes and protective clothing used in direct support of aviation maintenance
- Other consumable supplies, used in connection with aviation maintenance administration
- Replacement of consumable IMRL items used by the organizational or intermediate maintenance departments
- Consumable supplies used in the maintenance and upkeep of aviation ground support equipment

These costs, identifiable to a type/model/series aircraft, are available in virtually all levels of detail from Op-51C. The contact is Mr. Rymer (X-42128). Op-51C prepares an annual summary which is given to the VAMOSC project office. The VAMOSC-TSS methodology is to compute a total cost per flying hour and allocate to the activities based on accumulated flying hours. This has the effect of obscuring any substantive differences between fleets, Marine/Navy, etc. which were available in the source data. For more information on VAMOSC, contact CAPT Dowd, PMA270 (X-27966).

8c. Cost-Estimating Relationship

$$MMC = \frac{MM \times FHY}{1000}$$

$$MM = (-22.6417 + \underset{(4.31)}{0.1323MS} + \underset{(5.07)}{0.1407MMHMO}) \times 0.94$$

$\bar{R}^2 = 0.81$

$N = 15$

$F = 30.32$

$S.E.E. = 46.08$

where,

MMC = the annual cost (FY77$K) of maintenance material

MM = the cost per flying hour (FY77$) of maintenance material

FHY = the flying hours per year

MS = the maximum speed for level flight at altitude given in knots

MMHMO = the total maintenance manhours per month (direct maintenance manhours per flying hour (DMMH/FH) times flying hours per month (FM))

Note: The CER for MM is based on aggregate data which also contains the cost of Personnel Support Supplies (Element 9). Based on the data received from Op-51C, MM comprises 94% of the total and PSS 6%.

DATA BASE

Aircraft	Other Consumables (MM+PSS in FY77$)	MS	MMHMO
A-4M	100.0	515	479
RA-5C	471.2	1,164	2,420
EA-6B	294.8	538	1,768
A-6E	275.9	563	1,227
A-7E	126.3	606	920
C-1A	105.9	230	579
C-2A	217.5	306	1,216
E-2B	189.7	320	1,358
E-2C	187.6	320	1,092
F-4J	231.6	1,280	1,120
F-4N	288.0	1,280	906
RF-8G	296.3	1,174	1,214
F-14A	387.0	1,342	1,135
P-3C	125.3	409	1,134
S-3A	217.4	432	954

8d. Alternative CER

$$MMC = \frac{MM \times FHY}{1000}$$

$$MM = 0.5801 MS^{\underset{(3.26)}{0.4240}} \times MMHMO^{\underset{(2.54)}{0.4452}} \times 0.94$$

$\bar{R}^2 = 0.69$

$N = 19$

$F = 13.76$

$S.E.E. = 0.30$

where,

MMC = the annual cost (FY77$K) of maintenance material

MM = the cost per flying hour (FY77$) of maintenance material

FHY = the flying hours per year

MS = the maximum speed for level flight at altitude given in knots

MMHMO = the total maintenance manhours per month (direct maintenance manhours per flying hour (DMMH/FH) times flying hours per month (FM))

DATA BASE

Aircraft	Other Consumables (MM+PSS in FY77$)	MS	MMHMO
A-4M	100.0	515	479
RA-5C	471.2	1,164	2,420
EA-6B	294.8	538	1,768
A-6E	273.9	563	1,227
A-7E	126.3	606	920
C-1A	105.9	230	579
C-2A	217.5	306	1,216
E-2B	189.7	320	1,358
E-2C	187.6	320	1,092
F-4J	231.6	1,280	1,120
F-4N	288.0	1,280	906
RF-8G	296.3	1,174	1,214
F-14A	387.0	1,342	1,135
P-3C	125.3	409	1,134
S-3A	217.4	432	944
C-130F	116.4	326	1,302
P-3A	232.6	409	1,070
P-3B	113.7	409	1,361
US-2B	114.6	230	344

8e. Example Calculation

Assume:

$$DMMH/FH = 20$$

$$MMHMO = 600$$

$$MS = 600$$

$$FHY = 360$$

$$MM = \left[-22.6417 + 0.1323(600) + 0.1407(600)\right] \times 0.94$$

$$= 132.69 \text{ (FY77\$)}$$

$$MMC = \frac{132.69 \times 360}{1000}$$

$$= 47.8 \text{ (FY77\$K)}$$

9. PERSONNEL SUPPORT SUPPLIES

9a. Definition - This is the cost of all non-maintenance items used by the squadron for aircraft operations. It relates primarily to the health, safety and welfare of the aircrew.

9b. Discussion - This element is often grouped with Element 8, Maintenance Material, because they are both incurred at the same location (the organizational and intermediate levels) and are chargeable to the squadron's Operating Target (OPTAR). Personnel Support Supplies differ from Maintenance Material in that they are non-maintenance items. Technically, what is reported under this heading are gross adjusted obligations as contained in official accounting records for the following supplies:

- Flight clothing
- Personal survival equipment
- Consumable airborne photographic supplies
- Nitrogen
- LOX (liquid Oxygen) and aviator's breathing oxygen
- ADI (Anti-detonation injection) fluid
- Recording tape
- Graphs and chart paper
- Briefcases for charts
- Flight packet charges
- Cartons and dining packets used for flight rations
- Squadron administrative consumable supplies
- Safety shoes, protective helmets, and other safety items
- Incentive awards as prescribed in SECNAVINST 1650.24 series, at the discretion of the commanding officers and approved by TYCOM

Since these costs are reported in the same manner as Maintenance Material, the reader can refer to Section IV-8 for a complete discussion. Costs are available from Op-51C, Mr. Rymer (X-42128) or from the NALCOMIS O&S/VAMOSC System, PMA270, CAPT Dowd (X-27966).

9c. Cost-Estimating Relationship

$$PSS = \frac{PS \times FHY}{1000}$$

$$PS = \underset{(4.31)}{(-22.6417 + 0.1323MS} + \underset{(5.07)}{0.1407MMHMO)} \times 0.06$$

$$\bar{R}^2 = 0.81$$

$$N = 15$$

$$F = 30.32$$

$$S.E.E. = 46.08$$

where,

PSS = the annual cost (FY77$K) of personnel support supplies

PS = the cost per flying hour (FY77$) of personnel support supplies

FHY = the flying hours per year

MS = the maximum speed for level flight at altitude given in knots

MMHMO = the total maintenance manhours per month (direct maintenance manhours per flying hour (DMMH/FH) times flying hours per month (FM))

DATA BASE

Aircraft	Other Consumables (MM+PSS in FY77$)	MS	MMHMO
A-4M	100.0	515	479
RA-5C	471.2	1,164	2,420
EA-6B	294.8	538	1,768
A-6E	275.9	563	1,227
A-7E	126.3	606	920
C-1A	105.9	230	579
C-2A	217.5	306	1,216
E-2B	189.7	320	1,358
E-2C	187.6	320	1,092
F-4J	231.6	1,280	1,120
F-4N	288.0	1,280	906
RF-8G	296.3	1,174	1,214
F-14A	387.0	1,342	1,135
P-3C	125.4	409	1,134
S-3A	217.4	432	954

9d. Alternative CER

$$PSS = \frac{PS \times FHY}{1000}$$

$$MM = 0.5801 MS^{\underset{(3.26)}{0.4240}} \times MMHMO^{\underset{(2.54)}{0.4452}} \times 0.06$$

$\bar{R}^2 = 0.69$

$N = 19$

$F = 13.76$

$S.E.E. = 0.30$

where,

PSS = the annual cost (FY77$K) of personnel support supplies

PS = the cost per flying hour (FY77$) of personnel support supplies

FHY = the flying hours per year

MM = the cost per flying hour (FY77$) of maintenance material

MS = the maximum speed for level flight at altitude given in knots

MMHMO = the total maintenance manhours per month (direct maintenance manhours per flying hour (DMMH/FH) times flying hours per month (FM))

DATA BASE

Aircraft	Other Consumables (MM+PSS in FY77$)	MS	MMHMO
A-4M	100.0	515	479
RA-5C	471.2	1,164	2,420
EA-6B	294.8	538	1,768
A-6E	275.9	563	1,227
A-7E	126.3	606	920
C-1A	105.9	230	579
C-2A	217.5	306	1,216
E-2B	189.7	320	1,358
E-2C	187.6	320	1,092
F-4J	231.6	1,280	1,120
F-4N	288.0	1,280	906
RF-8G	296.3	1,174	1,214
F-14A	387.0	1,342	1,135
P-3C	125.4	409	1,134
S-3A	217.4	432	954

9e. Example Calculation

Assume:

$$DMMH/FH = 20$$

$$MMHMO = 600$$

$$MS = 600$$

$$FHY = 360$$

$$PS = \left[-22.6417 + 0.1323(600) + 0.1407(600)\right] \times 0.06$$

$$= 8.47 \text{ (FY77\$)}$$

$$PSS = \frac{8.47 \times 360}{1000}$$

$$= 3.0 \text{ (FY77\$K)}$$

10. BASE OPERATING SUPPORT

10a. Definition - This is the cost of base manpower and the operating funds necessary to provide the base services which support the squadron.

10b. Discussion - Included in this element are those personnel who are assigned to the base (not the squadron) and work in the laundry, mess, supply room and other areas. It also includes the base personnel who are permanently assigned to the AIMD of the air station. Since it is often difficult to determine the variable impacts on base operating support costs of the addition or deletion of a force unit such as an aircraft, the methodology used in the Navy Resource Model (NARM) Program Factors Manual was adopted to provide an estimate for Base Operating Support (B.O.S.) costs as well as several other elements which are similarly indirect in nature. Simply speaking, the NARM methodology identifies total support costs of specific type, such as B.O.S. costs, and allocates those costs back to the force units based on some proxy variable which is chosen to approximate that force unit's demand for support. Usually the proxy is direct manpower, although not always. In each case where the NARM methodology is used in succeeding element, it will be identified and the methodology, factors and proxies will be identified.

For B.O.S. the computation is done in the following manner. The costs contained in program elements 24611N, 24612N, 24613N, 24614N, 24615N, 24617N, 24618N, and 72827N are summed and divided by three, because only one-third of the total B.O.S. costs are considered variable with the forces.

The one-third of the fund which is to be allocated is done so based on the number of squadron personnel (including Integrated Services) associated with the aircraft, i.e., the more personnel required to operate and support the aircraft, the more base services are required. B.O.S. services consist of officer personnel, enlisted personnel and O&MN funds. Those factors used in the 1978 edition of the NARM Program Factors Manual are given in this report. Subsequent revisions or further information can be obtained from Ms. Ruth, Op-901 (X-55038).

10c. Cost-Estimating Relationship - The computation for Base Operating Support using the NARM factors is as follows:

$$BO = 0.0013 \times TDP$$

$$BE = 0.0172 \times TDP$$

$$BOM = 445.5947 \times TDP$$

$$BOS = (BO \times OPR) + (BE \times EPR) + BOM$$

where,

BO = the number of base operating officers necessary to provide support to the aircraft system

TDP = the number of total direct personnel (officers and enlisted) involved in operating and supporting the aircraft system. This is the sum of the personnel identified in Element 1 - Aircrew, Officer; Element 2 - Aircrew, Enlisted; Element 3 - Combat Command Staff; Element 5 - Other Deployed Manpower; and Element 7 - Aircraft Maintenance Manpower

BE = the number of base operating enlisted personnel required to support the aircraft system

BOM = the O&M funds necessary to support the aircraft system

BOS = the total cost (O&MN and MPN) of base operating support services

OPR = the officers pay rate (FY77$K = 22.14)

EPR = the enlisted pay rate (FY77$K = 9.52)

It is important to make note of three variables - the number of direct enlisted (ExCF) + EC + ODM + MO plus base operating enlisted (BE), hereafter referred to as direct plus base operating enlisted (DBE); the number of direct officers (OxCF) + OC plus base operating officers (BO), hereafter referred to as direct plus base operating officers (DBO); and the total of the two, hereafter referred to as direct plus base operating total (DBT). These variables are required by the NARM methodology and are used to compute costs for Elements 17 - Individual Training, 18 - Health care, and 19 - Personnel Support.

The equations are given below:

DBE = (ExCF) + EC + ODM + MO + BE

DBO = (OxCF) + OC + BO

DBT = DBE + DBO

where,

DBE = the total number of enlisted personnel, direct plus base operating, required to operate and provide base support to the aircraft system

E = the number of enlisted personnel per aircrew

CR = the crew factor

EC = the number of combat command staff enlisted divided by the number of squadron aircraft

ODM = the number of other deployed manpower per aircraft

MO = the number of maintenance and operating personnel required

BE = the number of base operating enlisted personnel required to support the aircraft system

DBO = the total number of officer personnel, direct plus base operating, required to operate and provide base support to the aircraft system

O = the number of officers per aircrew

OC = the number of combat command staff officers divided by the number of squadron aircraft

BO = the number of base operating officers necessary to provide support to the aircraft system

DBT = the total number of personnel, direct plus base operating support, required to operate and provide base support to the aircraft system

10d. Alternative CER - (none)

10e. Example Calculation

O = 1 (from Element 1)

CF = 1.42 (from Element 1)

E = 0 (from Element 2)

OC = 0.18 (from Element 3)

EC = 1.15 (from Element 3)

ODM = 2.51 (from Element 5)

MO = 12.47 (from Element 7)

TDP = 17.73

BO = 0.0013 x 17.73 = 0.023 (officers)

BE = 0.0172 x 17.73 = 0.305 (enlisted)

BOM = 0.4456 x 17.73 = 7.90 (FY77$K)

BOS = (0.023 x 22.14) + (0.305 x 9.52) + 7.90

= 11.3 (FY77$K)

also:

DBO = (OxCF) + OC + BO

= 1.42 + 0.18 + 0.02

= 1.62 officers

$$DBE = EA + EC + ODM + MO + BE$$

$$= 0 + 1.15 + 2.51 + 12.47 + 0.31$$

$$= 16.44$$

$$DBT = DBO + DBE$$

$$= 1.62 + 16.44$$

$$= 18.06$$

11. COMPONENT REWORK

11a. Definition - This is the cost of reworking or repairing components of the aircraft and its associated support equipment. This maintenance, which generally involves greater technical capability and more extensive facilities than are available at base level, is usually performed at the Naval Air Rework Facilities (NARF) but can also be done by another service or by a contractor. When the work is done by another service or a contractor, the cost is usually shown as a fixed price amount. When it is done by the NARF, it consists of labor, material and overhead.

11b. Discussion - Since the Navy manages its supply system, including the repair of repairable items, on an item basis, it is difficult to obtain visibility of costs relating to a particular type/model/series (t/m/s) aircraft. In other words, the item managers in the Navy work almost entirely on the basis of supply, demand and other related considerations for each particular item. It makes no difference, and no particular accounting track is maintained, whether an item demanded is for one particular t/m/s aircraft or another one. Since commonality of use is widespread in the aviation community, it makes assignment of component rework costs (and Replenishment Spares - Element 20) a particularly difficult problem. The problem stems primarily from the fact that the job control number assigned to an item removed from an aircraft or its support equipment and tracked by the Maintenance and Material Management System (3-M) is discarded when the item goes to the depot (NARF) for repair. A plan to extend the use of the 3-M job control number into the NARF, and therefore, provide t/m/s visibility, has never been implemented.

The VAMOSC system study report promised a relatively accurate system for allocating these costs to the various t/m/s aircraft, but unfortunately this methodology was simplified considerably during implementation with a corresponding loss of precision. This is discussed in detail in Appendix D.

The methodology which was implemented by VAMOSC is as follows. Total depot component rework costs are available from the Naval Aviation Logistics Center (NALC) and total component rework labor hours by Special Material Identification Code (SMIC) are provided by the Fleet Material Support Office (FMSO). The latter provides an identification of SMIC to type/model aircraft, and identification to t/m/s is allocated on the basis of flying hours. Therefore total component rework costs are allocated according to the SMIC labor hours, and t/m/s flying hours. More information concerning VAMOSC methodology can be obtained from NALCOMIS - O&S/VAMOSC-AIR System Description Manual , Volume 1, Total Support System, December 1977; or by contacting CAPT Dowd, PMA-270 (X-27966).

Despite the shortcomings of the VAMOSC data, it is nevertheless the best available, and perhaps the only source which is based on fleet experience.

11c. Cost-Estimating Relationship - The VAMOSC data was used to develop the following CER.

$$CR \quad \frac{CRF \times FHY}{1000}$$

$$CRF = \underset{}{43.2996} + \underset{(2.46)}{2.9875(MMHFH)} + \underset{(3.78)}{174.550AD}$$

$\bar{R}^2$ = 0.69

N = 14

F = 15.49

S.E.E. = 79.86

where,

CR = the annual cost of component rework (FY77$K)

CRF = the cost per flying hour of component rework

FHY = the flying hours per year

MMHFH = the number of direct maintenance man-hours per flying hour as defined and reported by the 3-M system

AD = an avionics dummy variable such that

AD = 1 for reconnaissance, electronics, ASW, and patrol aircraft

AD = 0 otherwise

DATA BASE

Aircraft	CRF (FY77$)	MMHFH (from 3-M)	AD
A-4M	100	18.7	0
EA-6B	218	50.7	1
A-7E	167	28.4	0
C-2A	166	34.1	0
P-3C	240	19.3	1
E-2C	435	27.4	1
S-3A	397	28.8	1
RA-5C	535	87.8	1
F-14A	193	47.1	0
RF-8G	272	49.1	1
P-3B	242	21.3	0
E-2B	370	39.0	1
C-1A	45	15.4	0
C-130F	68	16.7	0

11d. Alternative CER

$$CR = \frac{CRF \times FHY}{1000}$$

$$CRF = -50.9407 + \underset{(2.07)}{0.0125MS} + \underset{(3.34)}{0.1772MMHMO}$$

$\bar{R}^2 = 0.62$

$N = 12$

$F = 10.15$

$S.E.E. = 87.26$

where,

CR = the annual cost of component rework (FY77$K)

CRF = the cost per flying hour of component rework

FHY = the flying hours per year

MS = the maximum speed for level flight at altitude given in knots

MMHMO = the total maintenance manhours per month (direct maintenance manhours per flying hour (DMMH/FH) times flying hours per month (FM))

DATA BASE

Aircraft	CRF (FY77$)	MS (knots)	MMHMO (from 3-M)
A-4M	100	515	479
RA-5C	535	1,164	2,420
EA-6B	218	538	1,768
A-6E	407	563	1,227
A-7E	167	606	920
C-1A	45	230	579
C-2A	166	306	1,216
F-4J	334	1,280	1,120

DATA BASE (cont'd.)

Aircraft	CRF (FY77$)	MS (knots)	MMHMO (from 3-M)
F-4N	193	1,491	906
RF-8G	272	1,174	1,214
F-14A	416	1,342	1,135
P-3C	240	409	1,134

11e. Example Calculation

Assume:

$$MMHFH = 20$$

$$AD = 0$$

$$FHY = 360$$

$$CRF = 43.2996 + 2.9875(20) + 174.5500(0)$$

$$= 103.05$$

$$CR = \frac{103.05 \times 360}{1000}$$

$$= 37.1 \text{ (FY77\$K)}$$

12. AIRFRAME REWORK

12a. Definition - This is the cost including labor, material and overhead of making periodic inspections, repairs and overhaul of the airframe to assure its material condition.

12b. Discussion - Data concerning the depot repair of airframes is published quarterly in the Industrial Performance Summary of the Naval Air Rework Facilities by Code 2121B of the Naval Aviation Logistics Center (NALC), Patuxent River, MD. The NARF summary provides a detailed accounting of the number, type, location and costs of all airframe reworks. Currently, there are a number of programs which are part of the airframe rework program such as:

PAR[1]/CONVERSION

PILOT REWORK

INSPECT AND REPAIR

SDLM

SDLM[2] CRASH DAMAGE

SDLM CONVERSION

SDLM MODIFICATION

SDLM REPAIR

SDLM MOD REPAIR

---

[1]Progressive Aircraft Rework, an airframe rework philosophy which reached its peak in FY72, FY73.

[2]Standard Depot Level Maintenance

Each program is designed to meet a specific requirement and no effort will be made to discuss each one. It should be pointed out, however, that under normal circumstances, i.e., an aircraft is returned to the depot for rework at the planned time with no damage, major modifications, etc., the aircraft will undergo Standard Depot Level Maintenance (SDLM). OPNAV-NOTICE C4700 "Logistic Activity of Naval Aircraft" defines the major SDLM programs as follows:

> SDLM - Provides for a comprehensive inspection of selected aircraft structures and materials, critical defect correction, preventive maintenance as required, modification and technical directive compliance to ensure reliability and operational availability of the aircraft at minimum cost for the established operating service period and provides for intermediate support during the total life service.
>
> SDLM MODIFICATION - Accomplishment of the standard depot level maintenance concurrent with the installation of modifications which cause a major work effort.
>
> SDLM CRASH DAMAGE - In addition to accomplishing SDLM, repair and restoration to a servicable condition that part of the aircraft that has sustained damage resulting from an accident or an incident.
>
> SDLM CONVERSION - Accomplishment of the SDLM concurrent with the installation of modifications and other specified work which result in a change of model designation.

The procedure used in this model to process data on airframe rework is to collect both costs and number of units from the major SDLM programs - SDLM, SDLM REPAIR and SDLM CRASH DAMAGE and develop an accurate unit cost for a number of aircraft, which is used to develop a CER. Programs such as SDLM MODIFICATION and SDLM CONVERSION include costs which are outside the definition of airframe rework.

The VAMOSC system also contains data on airframe rework, but unfortunately, because of the way it is handled, it is not particularly suitable for CER development. VAMOSC obtains from the same NALC office total airframe rework dollars identified to type/model/series aircraft. This data is then distributed to the claimants (LANTFLT, PACFLT, etc.) on the basis of flying hours. The costs which are shown are not identified with a number of reworks. Therefore, if airframe rework cost increases 20% from one year to the next in the VAMOSC data, the reader has no basis on which to draw inferences. The unit costs could have increased 20%; or, workload could have increased 20% with the unit cost remaining the same - there is no way to tell. The long period (2-5 years) between airframe rework and the problems of scheduling at the depot routinely cause the workload of a particular t/m/s aircraft to vary widely. Since the VAMOSC data provides no visibility into the workload associated with the reported costs, it is therefore unsuitable for use in developing CER's.

If the analyst wants more information on the Industrial Performance Summary for the Naval Air Rework Facilities, contact Ms. Barsky NALC-Code 210: (AU8-356-3952).

12c. Cost-Estimating Relationship

$$AR = \frac{UAR \times 12}{I}$$

$$UAR = -54.9255 + \underset{(3.60)}{0.1574MMHMO} + \underset{(2.81)}{0.1354MS}$$

$\bar{R}^2 = 0.70$

$N = 14$

$F = 16.18$

$S.E.E. = 71.55$

where,

AR = the annualized cost of an airframe rework (FY77$K)

UAR = the unit cost of an airframe rework (FY77$K)

I = the airframe rework interval in months

MMHMO = the total maintenance manhours per month (direct maintenance manhours per flying hour (DMMH/FH) times flying hours per month (FM))

MS = the maximum speed for level flight at altitude given in knots

DATA BASE

Aircraft	UAR (FY77$)	MMHMO	MS (knots)
RA-5C	506.7	2,420	1,164
EA-6B	176.0	1,768	538
A-6E	191.3	1,227	563
A-7E	92.1	920	606
C-1A	47.4	479	174
C-2A	209.8	1,216	306
C-130F	260.9	1,302	326
F-4J	196.8	1,120	1,280
F-4N	250.7	1,088	1,280
RF-8G	356.8	1,214	1,174
F-14A	409.4	1,135	1,342
P-3B	261.1	1,361	409
P-3C	207.9	1,134	409
US-2B	40.2	344	230

12d. Alternative CER

$$AR = \frac{UAR \times 12}{I}$$

$$UAR = -39.42309 + \underset{(4.08)}{5.0021}MMHFH + \underset{(2.17)}{1.3270}GT$$

$$\bar{R}^2 = 0.522$$

$$N = 16$$

$$F = 9.20$$

$$S.E.E. = 90.70$$

where,

AR = the annualized cost of an airframe rework (FY77$K)

I = the airframe rework interval in months

MMHFH = the number of direct maintenance manhours per flying hour as defined and reported by the 3-M system

GT = the gross take-off weight of the aircraft in thousands of pounds

DATA BASE

Aircraft	UAR (FY77$)	MMHFH	GT (thous. of lbs.)
RA-5C	506.7	87.8	80.0
EA-6B	176.0	50.7	58.6
A-6E	191.3	47.4	58.6
A-7E	92.1	28.4	42.1
C-1A	47.4	15.4	30.0
C-2A	209.8	34.1	54.9
C-130	260.9	16.7	155.0
E-2B	426.2	39.0	51.8
E-2C	254.5	27.4	51.8
F-4J	196.8	47.7	54.7
F-4N	250.7	56.5	54.7

DATA BASE (cont'd.)

Aircraft	UAR (FY77$)	MMHFH	GT (thous. of lbs.)
RF-8G	356.8	49.1	30.0
F-14A	409.4	54.2	72.1
P-3B	261.1	21.3	134.9
P-3C	207.9	19.3	134.9
S-3A	40.2	18.3	42.5

12e. Example Calculation

Assume:

$$I = 36 \text{ months}$$

$$MMHMO = 600$$

$$MS = 600$$

$$UAR = -54.9255 + 0.1574(600) + 0.1354(600)$$

$$= 120.75$$

$$AR = \frac{120.75 \times 12}{36}$$

$$= 40.3 \text{ (FY77\$K)}$$

13. ENGINE REWORK

13a. Definition - This is the cost of repairing and overhauling aircraft engines at the Naval Air Rework Facilities or facilities of other services or contractors.

13b. Discussion - The philosophy of depot rework of engines has recently undergone a major change. Simply stated, the previous policy of overhauling an engine when it reached a certain number of operating hours (usually one thousand) has given way to a policy of scheduling overhauls only for certain engine modules. Total engine overhauls and, of course, repairs are done on an "as needed" basis.

The new engine maintenance policy is documented in the "Engine Analytical Maintenance Plan" (EAMP) Revision A, 28 February 1978. It is available from Captain Rush, NAVAIR 411, (X-29537) and currently applies to the following engines:

J52	TF30	T56	T76
J79	TF41	T58	
J60	F402	T64	
J85	F404	T400	

Detailed data for the depot rework of engines can be found in the NARF summary. Since the NARF summary was discussed in the preceding element, it will not be discussed further here except to say that it provides detailed information on the number of engines reworked, the cost of rework, manhours per unit, etc. by each specific program - Overhaul, Conversion, Repair and others. This allows the analyst to closely examine the numbers of engines

reworked, the types of program and the costs; and to develop accurate CER's to estimate unit costs. The analyst can also easily determine from the NARF data the relative incidence of repairs vs. overhauls. For FY77 for the engines in the sample, the average was five repairs to an overhaul, although this varies from engine to engine and will probably vary considerably in the future, since implementation of the revised maintenance plan is just beginning. All that is left to do is develop a capability to estimate the workload.

A Maintenance and Material Management System (3-M) report "AIMD Engine Maintenance Evaluation Report" - MSOD 4790.A3063-01 provides accurate and complete data on the numbers of engines removed from the aircraft at the intermediate level and what disposition is made of those engines. Simply speaking, there are three things that can happen: 1) the engine can be repaired at the IMA and reinstalled in the aircraft; or 2) it can be beyond capability of intermediate maintenance and sent to the depot; or 3) it can be sent to the depot by direction of higher authority. The third alternative could be a scheduled overhaul or any one of a number of other reasons such as installation of a safety modification, conversion, etc. Whatever the reason, it is quite easy for the analyst to compute the percentage of engines removed which are sent to depot. Tables C-4 and C-5 of Appendix C contain a sample of removal data for a number of engines. As with the repair/overhaul ratio at the depot, the ratios exhibited in this data will undoubtedly change significantly as the revised EAMP is implemented. Copies of the "AIMD Engine Maintenance Evaluation Report" - MSOD 4790.A3063-01 can be obtained from Mr. Pierucci, MSOD (Au8-277-2669) or (717-790-2669); or may be viewed at the NAVAIR 04 Technical Reference Library, 4th floor JP2. Contact Ms. Akers, (X-21104).

13c. Cost-Estimating Relationship

$$ERT = \left(\frac{(ORR \times ERO) + ERM}{(1 + ORR) \times DAR}\right) \times EN \times FHY$$

$$ERO = \underset{}{28.8755} + \underset{(2.77)}{1.6700TH} + \underset{(2.12)}{87.7879FD}$$

$\bar{R}^2 = 0.97$

$N = 7$

$F = 110.55$

$S.E.E. = 7.87$

$$ERM = \underset{}{12.5968} + \underset{(5.15)}{0.8153TH} + \underset{(4.68)}{7.8157FD}$$

$\bar{R}^2 = 0.92$

$N = 8$

$F = 41.90$

$S.E.E. = 2.07$

where,

ERT = the total cost of engine rework (FY77$K)

ORR = the overhaul/repair ratio, i.e., the number of a certain type engine overhauled in a year divided by the number repaired in a year

ERO = the unit cost of overhauling an engine at the depot (FY77$K)

DAR[1] = the depot arrival rate in operating hours, i.e., the total operating hours accumulated by the engines divided by the number of engines requiring depot repair

---

[1]DAR can also be defined as the base removal rate divided by the intermediate ratio. Example data for both of these factors is contained in Tables C-4 and C-5 of Appendix C.

ERM = the unit cost of repairing an engine at the depot (FY77$K)

EN = the number of engines mounted on the aircraft

FHY = the flying hours per year

TH = engine thrust in thousands of pounds

FD = a dummy variable such that
FD = 1 if the engine is a fan
FD = 0 otherwise

DATA BASE
(Engine Overhaul)

Engine	ERO (FY77$)	TH (Thous. of lbs.)	FD
J52-P8B	47.1	9.3	0
J52-P408	49.5	11.2	0
J79-GE8	60.9	17.0	0
J79-GE10	57.3	17.9	0
TF30-P408	148.4	13.4	1
TF30-P412A	140.7	20.0	1
J85-GE4A	27.1	3.0	0

DATA BASE
(Engine Repair)

Engine	ERM (FY77$)	TH (Thous. of lbs.)	FD
J52-P8B	20.2	9.3	0
F52-P408	19.0	11.2	0
J79-GE8	26.6	17.0	0
J79-GE10	28.4	17.9	0
TF30-P408	33.0	13.4	1
TF30-P412A	37.7	20.0	1
J85-GE4A	16.4	3.0	0
TF41-A2	30.0	15.0	1

13d. Alternative CER

$$ERT = \left(\frac{(ORR \times ERO) + ERM}{(1 + ORR) \times DAR}\right) \times EN \times FHY$$

$$ERO = -16.5473 + \underset{(2.06)}{2.0877}D + \underset{(2.60)}{49.129}FD$$

$\bar{R}^2 = 0.80$

$N = 8$

$F = 15.44$

S.E.E. = 19.71

$$ERM = 10.3804 + \underset{(2.88)}{9.1562}FD + \underset{(2.84)}{0.8696}TH$$

$\bar{R}^2 = 0.78$

$N = 9$

$F = 14.8$

S.E.E. = 4.02

where,

ERT = the total cost of engine rework (FY77$K)

ORR = the overhaul/repair ratio, i.e., the number of a certain type of engine overhauled in a year divided by the number repaired in a year

ERO = the unit cost of overhauling an engine at the depot (FY77$K)

ERM = the unit cost of repairing an engine at the depot (FY77$K)

DAR = the depot arrival rate in operating hours, i.e., the total operating hours accumulated by the engines divided by the number of engines requiring depot repair

EN = the number of engines mounted on the aircraft

FHY = the flying hours per year

D = the engine diameter in inches

FD = a dummy variable such that

FD = 1 if the engine is a fan, FD = 0 otherwise

TH = engine thrust in thousands of pounds

DATA BASE
(Engine Overhaul)

Engine	ERO (FY77$)	D (inches)	FD
J52-P8B	47.1	30.2	0
J52-P408	49.5	30.2	0
F79-GE8	60.9	38.3	0
J79-GE10	57.3	39.1	0
TF30-P408	148.4	42.0	1
TF30-P413A	140.7	50.0	1
J85-GE4A	27.1	17.7	0
TF41-A2	79.0	37.5	1

DATA BASE
(Engine Repair)

Engine	ERM (FY77$)	TH (Thous.of lbs.)	FD
J52-P8B	20.2	9.3	0
J52-P408	19.0	11.2	0
J57-P10	11.6	10.5	0
J79-GE8	26.6	17.0	0
J79-GE10	28.4	17.9	0
TF30-P408	33.0	13.4	1
TF30-P412A	37.7	20.0	1
J85-GE4A	16.4	3.0	0
TF41-A2	30.0	15.0	1

13e. Example Calculation

Assume:

ORR = 0.25 (one overhaul to four repairs)

DAR = 400 hours (engine removal rate is 200 hours and intermediate ratio is 0.5

EN = 1

FHY = 360 hours

TH = 16 (thousands of lbs.)

FD = 1 (engine is a fan)

ERO = 28.8755 + 1.6700(16) + 87.7879(1)

= 143.4 (FY77$K)

ERM = 12.5968 + 0.8153(16) + 7.8157(1)

= 33.5 (FY77$K)

$$ERT = \frac{(.25 \times 143.4) + 33.5}{(1 + .25) \times 400} \times 1 \times 360$$

= 0.1387 x 1 x 360

= 49.9 (FY77$K)

14. DEPOT SUPPLY OPERATIONS

14a. Definition - This is the cost of manpower and material needed to buy, store, package, manage and control supplies, spares and repair parts used in operating and maintaining aircraft, aircraft components and support equipment. When a new aircraft is introduced into the force, spare parts are procured to sustain operations. These parts are introduced into the supply system and resources are expended to manage, store, distribute, package and crate both the spares inventory and other common supply items which support aircraft system personnel.

14b. Discussion - This cost is computed from the Navy Resource Model Program Factors Manual by taking the costs contained in program element 71111N - Supply Depot Operations, of the budget and allocating to force units on the basis of direct requirements of manpower and operating funds, i.e., MPN, O&MN, and APN.

14c. Cost-Estimating Relationship - The equation for estimating the cost of supply depot operations is:

$$SDO = 0.0247DR$$

where,

SDO = the annual cost of supply depot operations required to support a weapon system (FY77$K)

DR = the direct requirements of manpower and operating funds represented by the total cost of Elements 1-5, 7-9, 11-13 (FY77$K)

14d. Alternative CER - None.

14e. Example Calculation

Element	Variable	Computed Cost
1	OA	31.4
2	EA	0
3	CCS	14.9
4	POL	95.1
5	ODMC	23.9
7	AMM	118.7
8	MMC	47.8
9	PSS	3.0
11	CR	37.1
12	AR	40.3
13	ERT	49.9
	DR	462.1

SDO = 0.0247 x 462.1

= 11.4 (FY77$K)

15. TECHNICAL SUPPORT

15a. Definition - This is the cost of a number of programs usually managed centrally, which support aircraft operations. A partial list of these programs is given below:

- Contractor Engineering Technical Services (CETS)
- Navy Engineering Technical Services (NETS)
- Depot Rework of Ground Support Equipment (GSE)
- Installation and Calibration of GSE
- Depot Rework of Catapult and Arresting Gear
- Technical Publications Updates
- NAVAIRSYSCOM Representatives

15b. Discussion - Since these activities support many weapon systems, it is advantageous to use the methodology in the Navy Resource Model Program Factors Manual to estimate this cost. The NARM methodology includes both Supply Depot Operations (Element 14) and Second Destination Transportation (Element 15) in the computation of Technical Support. These costs must be subtracted.

15c. Cost-Estimating Relationship

$$TS = 0.4760RS + 0.3317ACR + 0.1941ACO - SDO - SDT$$

$$ACR = CR + AR + ERT$$

$$ACO = POL + MMC + PSS$$

where

TS = the annual cost of technical support (FY77$K)

RS = the annual cost of Replenishment Spares - Element 20 (FY77$K)

ACR = the annual cost of aircraft rework which is the is the sum of Component Rework - Element 11, Airframe Rework - Element 12, and Engine Rework - Element 13 (FY77$K)

ACO = the annual cost of aircraft operations, which is the sum of Aviation POL - Element 4, Maintenance Material - Element 8, and Personnel Support Supplies - Element 9.

SDO = the annual cost of supply depot operations required to support a weapon system (FY77$K)

SDT = the annual cost of second destination transportation (FY77$K)

15d. Alternative CER - None

15e. Example Calculation

RS = 21.2 (from Element 20)
CR = 37.1 (from Element 11)
AR = 40.3 (from Element 12)
ERT = 49.9 (from Element 13)
POL = 95.1 (from Element 4)
MMC = 47.8 (from Element 8)
PSS = 3.0 (from Element 9)
SDO = 11.4 (from Element 14)
SDT = 26.4 (from Element 16)

$$ACR = CR + AR + ERT$$
$$= 37.1 + 40.3 + 49.9$$
$$= 127.3$$
$$ACO = POL + MMC + PSS$$
$$= 95.1 + 47.8 + 3.0$$
$$= 145.9$$
$$TS = 0.4760(21.2) + 0.3317(127.3) + 0.1941(145.9) - 11.4 - 26.4$$
$$= 42.8 \text{ (FY77\$K)}$$

16. SECOND DESTINATION TRANSPORTATION

16a. Definition - This is the cost of shipping material needed to support the aircraft unit. Material includes: (1) spare and repair parts that are shipped between the centralized repair depots and the aircraft unit; and (2) support items that are needed by aircraft unit personnel such as food and administrative supplies.

16b. Discussion - The NARM Factors Manual estimates second destination transportation by allocating the costs contained in program element 78010N - Second Destination Transportation, on the basis of direct requirements of operating funds.

16c. Cost-Estimating Relationship

$$SDT = 0.0572_{DR}$$

where,

SDT = the annual cost of second destination transportation (FY77$K)

DR = the direct requirements of manpower and operating funds represented by the total cost of Elements 1-5, 7-9, 11-13 (FY77$K)

16d. Alternative CER - None.

16e. Example Calculation

DR = 462.1 (from Element 14)

SDT = 0.0572 x 462.1

= 26.4 (FY77$K)

17. INDIVIDUAL TRAINING

17a. Definition - This is the cost of paying personnel in training who will replace unit personnel, the training staff and training operating funds. This includes all training from recruit training through undergraduate pilot and navigator training, as well as the operation and maintenance of trainers and simulators by the Fleet Aviation Specialized Operational Training Detachments (FASOTRADET's) and the Naval Air Maintenance Training Detachments (NAMTRADET's). This element does not include any aspect of readiness training, which is costed as a separate squadron.

17b. Discussion - The NARM computes this cost by summing all of the costs of the students and two-thirds the cost of staff personnel and operating funds for the program elements shown below and allocating to the aircraft on the basis of personnel.

24633N	Fleet Support Training
84711N	Recruit Training Units
84722N	Officer Candidate Schools
84731N	General Skill Training
84751N	Professional Military Education
84752N	Other Professional Education
85796N	Base Operations, Training
86723N	Other Health Acq. Programs
86761N	Education & Training, Health Care
89731N	Training Support to Units

17c. Cost-Estimating Relationship

$$TOM = 0.0040(DBE) + 0.0701(DBO) + 0.2798(DBT)$$

$$TO = 0.0605(DBO) + 0.0027(DBT) + 0.0001(DBE)$$

$$TE = 0.0934(DBE) + 0.0290(DBT) + 0.0067(DBO)$$

$$TT = TOM + (TO \times OPR) + (TE \times EPR)$$

where,

TOM = training O&M funds

DBE = the number of squadron enlisted personnel (from Elements 2,3,5 and 7) and base operating enlisted (from Element 10) as defined in Section 10c.

DBT = the number of squadron enlisted personnel and officers and base operating enlisted and officers as defined in Section 10c.

TO = the number of officer staff required for training duties

DBO = the number of squadron officers and base operating officers as defined in Section 10c.

TE = the number of enlisted personnel required for training duties

TT = total training cost

OPR = officer pay rate (FY77$K) = 22.14

EPR = enlisted pay rate (FY77$K) = 9.52

17d. Alternative CER - None

17e. Example Calculation

DBO = 1.62 (from Element 10)

DBE = 16.44 (from Element 10)

DBT = 18.06 (from Element 10)

TOM = 0.0040(16.44) + 0.0701 (1.62) + 0.2798(18.06)

= 5.23 (FY77$K)

TO = 0.0605(1.62) + 0.0027(18.06) + 0.0001(16.44)

= 0.15 officer

TE = 0.0934(16.44) + 0.0209(18.06) + 0.0067(1.62)

= 1.92 enlisted

TT = 5.23 + (0.15 x 22.14) + (1.92 x 9.52)

= 26.8 (FY77$K)

18. HEALTH CARE

18a. Definition - Health care is the cost of medical personnel and materials needed to provide medical support to aircraft unit personnel and to base personnel who provide direct support to the aircraft.

18b. Discussion - The NARM estimates this cost by summing two-thirds (2/3) of the cost of medical operations. The program elements are:

81211N	Hospitals
87711N	Care in Defense Facilities
87714N	Other Health Activities
81213N	Patients

18c. Cost-Estimating Relationship

$$HO = 0.0099DBT$$

$$HE = 0.0192DBT$$

$$HOM = 0.3765DBT$$

$$HT = (HO \times OPR) + (HE \times EPR) + HOM$$

where,

HO = the number of health care officers necessary to support the weapon system

DBT = the number of squadron enlisted personnel and officers (from Elements 1,2,3,5, and 7) and base operating enlisted and officers (from Element 10)

HE = the number of health care enlisted personnel

HOM = health care O&M funds (FY77$K)

DBO = the number of squadron officers and base operating officers

HE = the number of health care enlisted personnel

DBE = the number of squadron enlisted personnel (from Elements 2,3,5, and 7) and base operating enlisted (from Element 10) as defined in Section 10c.

HT = the total cost of health care

OPR = officer pay rate (FY77$K = 22.14)

EPR = enlisted pay rate (FY77$K = 9.52)

18d. Alternative CER - None.

18c. Example Calculation

$$HO = 0.0099(18.06)$$

$$= 0.18 \text{ officers}$$

$$HE = 0.0192(18.06)$$

$$= 0.35$$

$$HOM = 0.3765(18.06)$$

$$= 6.80 \text{ (FY77\$K)}$$

$$HT = 6.80 + (0.18 \times 22.14) + (0.35 \times 9.52)$$

$$= 14.2 \text{ (FY77\$K)}$$

19. PERSONNEL SUPPORT

19a. Definition - Personnel support is comprised of two parts. The first part consists of the costs incident to the permanent change of station (PCS) of squadron and base operating oersonnel, either individually or as an organized unit. The second portion is the cost of recruiting and examining activities, the cost of transient personnel, and the cost of prisoners.

19b. Discussion - PCS rates are figured in the Navy Resource Model Program Factors Manual by dividing the total PCS cost by the number of personnel, producing an annual PCS cost per person (officers'enlisted). This is applied to the number of personnel operating and supporting the system to obtain an estimate. The other costs, recruiting and examining, transients and prisoners, are estimated by the NARM by summing two-thirds (2/3) of the cost of recruiting and examining activities and all of the costs associated with transients and prisoners and allocating these costs to the weapon system on the basis of the number of personnel. The program elements are given below:

81711N	Recruiting Activities
81713N	Recruiting Activities
88732	Transients
88721N	Personnel Holding Account
88731N	Permanent Change of Station

19c. Cost-Estimating Relationship

$$PCS = 1.2930DBO + 0.4460DBE$$

$$REOM = 0.0635DBE$$

$$REO = 0.0009DBE$$

$$REE = 0.0072DBE$$

$$OH = 0.0008DBO$$

$$EH = 0.0124DBE$$

$$TOT = 0.0606DBO$$

$$TET = 0.0449DBE$$

$$TPA = REOM + (REO + OH + TOT) \times OPR + (REE + EH + TET) \times EPR + PCS$$

where,

PCS = the annual cost (MPN funds) of PCS for weapon system direct and base operating personnel (FY77$K)

DBO = the number of squadron officers and base operating officers as defined in Section 10c.

DBE = the number of squadron enlisted personnel (from Elements 2,3,5, and 7) and base operating enlisted (from Element 10) as defined in Section 10c.

REOM = recruiting and examining O&M funds (FY77$K)

REO = the number of recruiting and examining officers necessary to support the weapon system

REE = the number of recruiting and examining enlisted necessary to support the weapon system

EH = the number of enlisted personnel in the holding account

OH = the number of officer personnel in the holding account

TOT = the number of officers in transit

DBT = the number of squadron enlisted personnel and officers and base operating enlisted and officers as defined in Section 10c.

TET = the number of enlisted personnel in transit

TPA = the total cost of personnel support (FY77$K)

OPR = officer pay rate (FY77$K = 22.14)

EPR = enlisted pay rate (FY77$K = 9.52)

19d. Alternative CER - None

19e. Example Calculation

Assume:

DBO = 1.62 officers

DBE = 16.44 enlisted

DBT = 18.06 total personnel

PCS = 1.2930(1.52) + 0.4460(16.44)

= 9.4 (FY77$K)

REOM = 0.0635(16.44)

= 1.0 (FY77$K)

REO = 0.0009(16.44)

= 0.01 officers

REE = 0.0072(16.44)

= 0.12 enlisted

EH = 0.0124(16.44)

= 0.20 enlisted

OH = 0.0008(1.62)

= 0.00 officers

TOT = 0.0606(1.62)

= 0.10 officers

TET = 0.0447(16.44)

= 0.73 enlisted

TPA = 1.0 + (0.01 + 0.00 + 0.10) x 22.14 + (0.12 + 0.20 + 0.73) x 9.52 + 9.4

= 22.8 (FY77$K)

20. REPLENISHMENT SPARES

20a. Definition - This is the cost of procuring aircraft assemblies, spares and repair parts which are normally repaired and returned to stock. In addition, it includes procurement of stock levels that are not provided by Initial Spares procurement.

20b. Discussion - All procurement of investment or repairable material is purchased with funds from the APN-6 appropriation and is divided into two parts - Initial Spares and Replenishment Spares. These two major parts can also be divided into the following subparts:

Initial Spares	Replenishment Spares
. Spare Engines	. Follow-on Outfittings
. Interim (Contractor) Spares	. Basic Replenishment
. Inventory Control Point (ICP) Managed Spares	. Pre-Positioned War Reserve Material
. PGSE Spares	
. Modification Spares	

Over the last five years there have been two major changes in policy regarding Initial Spares vs. Replenishment Spares funding criteria and, as a result confusion still exists. Perhaps the easiest way to explain the current policy is to discuss each part and subpart separately.

Spare Engines - Spare Engines are always funded with Initial Spares funds.

Interim (Contractor) Spares - Interim (Contractor) Spares are also funded with Initial Spares funds, but this activity ceases at the Material Support Date (MSD), or as it is also called, Navy Support Date (NSD), when the Navy assumes the responsibility for supporting the system.

ICP Managed Spares - The situation with ICP Managed Spares is considerably more complicated and is the cause of the confusion. In FY1974 and prior, all new outfitting of sites was funded with Initial Spares funds. Often in large programs, this meant the expenditure of initial spares money many years after initial operational capability (IOC) of the aircraft. It was argued that the demand pattern for these items had long since been established and therefore they should be funded with Replenishment Spares money. Beginning with FY1975 and prompted by a revosed DoD Instruction 4140.40 (copy enclosed as Table C-6 of Appendix C), it was decided that the funding of initial outfitting with Initial Spares money would terminate eighteen months after the Navy Support Date (NSD). Accordingly, the funds in question migrated to the Replenishment section of APN-6 and were called Follow-on Initial Spares. In a 17 November 1976 memorandum (contained as Table C-7 of Appendix C) Admiral Cook, then Deputy Chief of Naval Material, further refined this policy by requiring that only the initial procurement by the inventory control point (ICP) be included in Initial Spares funding and the remainder in Replenishment funding. What this means as a practical matter is that the first year of initial outfitting is funded with Initial Spares funds and the remainder is Replenishment (Follow-on Initial). There is an exception to this. After the one year cut-off, 10% of the requirements are still funded with Initial Spares money to pay for spare parts required by production line Engineering Change Proposals (ECP's). This, of course, ends with the end of production.

PGSE Spares - Peculiar Ground Support Equipment (PGSE) Spares are handled the same as ICP Managed Spares.

Modification Spares - Modification Spares are handled the same as ICP Managed Spares.

Follow-on Initial Spares - The Follow-on Initial Spares funding provides for all outfitting after the initial ICP procurement.

Basic Replenishment - Basic Replenishment funding provides for replacement of spares lost through attrition, to meet other demand-related requirements and to satisfy other inventory initiatives.

Pre-Positioned War Reserve Material - The cost of Pre-positioned War Reserve Material is not considered in O&S cost analyses since it is specifically excluded by the CAIG guidelines.

Since the funding of Follow-on Initial Spares has recently migrated from Initial to Replenishment, no guidance has been provided regarding how this cost should be handled in a CAIG/DSARC analysis. The analyst must be certain to ascertain that it has been addressed, either in the Procurement Section of the analysis or in the Operating and Support Section. The CER's provided in this section address only the Replenishment portion of APN-6 Spares. No further discussion of Follow-on Initial Spares will be given other than to say that, in their preparation, the costs are identified to a particular t/m/s aircraft. Further information can be obtained by contacting Mr. Conrad, NAVAIR 4123 (X-20239).

Obtaining data on the Replenishment Spares costs incurred by a particular type/model/series has always been a frustrating task. The reason for this stems from the way these items are managed. Although the management of secondary items is an extremely complicated procedure, it can generally be described as being based on the item, rather than the end-user, the weapon system. This is done to coordinate, integrate, and improve the efficiency of the supply system. For instance, when a procurement contract is let for an item such as a radio, it makes no difference to the item manager whether the radio is for an F-4J or some other aircraft, he simply knows that he has X number of them in inventory and his demand is Y and that the integrated supply system has indicated that it is necessary and efficient to reorder.

Data are available to permit one to track the purchased material to a user aircraft, with a small amount of allocation required, but the task would be extremely tedious and costly, and so far, no one has been willing

to sponsor such an effort. The VAMOSC system provides what is the best substitute for such an effort. Its data are published annually and are identified by type/model/series aircraft.

VAMOSC collects the value of items which are Beyond Capability of Maintenance (BCM), codes 1-8, at the intermediate level and surveyed (discarded) at the depot level. These data have several drawbacks:

1. The data is based on attrition rather than on purchases. The latter is the cost which must be included in the budget and funded each year while the former is not. As will be discussed later, there is a significant difference.

2. The information from the depot is allocated based on historical repair/survey ratios rather than actual survey information.

In looking at comparative totals for total Replenishment Spares costs for VAMOSC and from the budget, it is easily seen that the VAMOSC method omits a major portion of the costs.

COMPARISON OF REPLENISHMENT SPARES
(Then year $ in mil.)

	76	TQ	77
APN-6 Replen. Spares	128.5	29.3	154.7
VAMOSC Replen. Spares	44.0	10.8	34.3
RATIO	2.9:1	2.7:1	4.5:1

Despite this problem of omission, VAMOSC provides the only data source for spares which is in any way based on actual fleet experience. It can be easily used as a relative measure of spares purchases. For more information on VAMOSC, contact CAPT Dowd, PMA-270 (X-27966).

20c. Cost-Estimating Relationship - Using VAMOSC data as a source and multiplying the result by 4.5 to account for the omitted costs, the following CER was derived:

$$RS = \frac{RSF \times FHY}{1000}$$

$$RSF = 4.5\ (-2.9149 + \underset{(6.18)}{0.0194MS} + \underset{(1.96)}{0.0074MMHMO})$$

$\bar{R}^2 = 0.86$

$N = 12$

$F = 27.8$

$S.E.E. = 4.48$

where,

RS = the annual cost of procuring APN-6 Replenishment Spares to support the aircraft system (FY77$K)

RSF = the cost per flying hour of procuring APN-6 Replenishment Spares to support the aircraft system (FY77$)

FHY = the flying hours per year

MS = the maximum speed for level flight at altitude given in knots

MMHMO = the total maintenance manhours per month (direct maintenance manhours per flying hour (DMMH/FH) times flying hours per month (FM)

DATA BASE

Aircraft	RSF	MS (knots)	MMHMO
A-4M	12.8	518	479
EA-6B	19.8	538	1,768
A-6E	27.0	563	1,227
A-7E	15.9	606	920
F-40	26.5	1,280	1,120

DATA BASE (cont'd.)

Aircraft	RSF	MS (knots)	MMHMO
F-14A	34.5	1,342	1,135
P-3C	7.7	409	1,134
S-3A	10.4	432	955
F-4N	33.5	1,491	906
RF-8G	26.4	1,174	1,214
US-2B	3.7	230	344
C-1A	4.6	230	579

20d. Alternative CER

$$RS = \frac{RSF \times FHY}{1000}$$

$$RSF = \underset{(3.22)}{4.5(19.7314} + \underset{}{0.0148MS} \underset{(-1.78)}{- 11.9640MTBF)}$$

$$\bar{R}^2 = 0.76$$

$$N = 9$$

$$F = 13.62$$

$$S.E.E. = 484$$

where,

RS = the annual cost of procuring APN-6 Replenishment Spares to support the aircraft system (FY77$K)

RSF = the cost per flying hour of procuring APN-6 Replenishment Spares to support the aircraft system (FY77$)

FHY = the flying hours per year

MS = the maximum speed for level flight at altitude given in knots

MTBF = the mean-time-between-failures (hours) as reported by the 3-M system

DATA BASE

Aircraft	RSF	MS (knots)	MTBF
A-4M	12.8	515	1.5
EA-6B	19.8	538	0.6
A-6E	27.0	563	0.7
A-7E	15.9	606	1.0
F-4J	25.4	1,280	0.7
F-14A	34.5	1,342	0.7
P-3C	7.7	409	1.0
S-3A	10.4	432	1.2
F-4N	33.2	1,491	0.7

20e. Example Calculation

Assume:

$$FHY = 360$$

$$MS = 600$$

$$MMHMO = 600$$

$$RSF = 4.5(-2.9149 + 0.0194(600) + 0.0074(600))$$

$$= 59.0 \text{ (FY77\$K)}$$

$$RS = \frac{59.0 \times 360}{1000}$$

$$= 21.2 \text{ (FY77\$K)}$$

21. MODIFICATIONS

21a. Definition - The cost of modifying aircraft, ground equipment, and training equipment to enable them to perform mission essential tasks (not new capability), and to improve reliability or reduce maintenance cost. This includes the cost of purchasing the modifications including the requisite engineering plus the cost of depot installation. There are no installation costs involved at the organizational and intermediate levels since those personnel are dedicated to support of the aircraft and their time is included in the other cost elements.

21b. Discussion - The requirements for modifications are dependent upon many things which are not predictable or easily treated on an analytical basis. For example, the nature of the development program seems to bear heavily on the need for modifications. If the program is rushed through development, the number of Engineering Change Proposal's (ECP's) is larger than for programs that spent a long time in development. Data on the procurement of modification material is available in the budget back-up material. Modifcations are budgeted in APN-5; however, no distinction is made between safety/maintenance/reliability, etc, modifications and conversion/new capability modifications. The former fall within the definition given by the CAIG while the latter do not. Exhibit IV-4 contains modification data taken from the FY79 budget Back-up submitted to Congress. It provides total requested authorization for aircraft modifications as well as the O&MN to install the modifications. The APN-5 procurement data is broken down by type/model aircraft

EXHIBIT IV-4

Modification Costs

	77 Estimate	78 Estimate	79 Estimate	80 Estimate
APN-5 Modification of A/C ($M)	559.7	827.5	997.7	918.0
O&M Installation of Mod. ($M)	39.2	82.3	102.4	*

APN-5 Modification of A/C by Type Model ($M)	79 Estimate	80 Estimate
A-3	7.5	3.7
A-4	22.7	17.7
A-6	149.6	149.2
EA-6	10.8	35.0
A-7	61.2	57.8
AV-8	16.9	27.9
F-4	108.1	80.4
RF-4	35.9	2.0
F-5	2.9	0.4
F-14	58.1	87.4
OV-10	2.1	0
H-46	142.2	113.8
H-53	53.7	39.0
H-1	19.2	30.2
H-2	11.3	6.5
H-3	53.6	9.2
EP-3	3.1	0
P-3	90.0	91.1
S-3	34.9	48.8

*No figure given

EXHIBIT IV-4 (cont'd.)

APN-5 Modification of A/C by Type Model ($M)	79 Estimate	80 Estimate
E-2	18.2	25.0
TC-4	9.3	0
C-2	2.6	2.7
C-130	17.7	19.7
EC-130	28.0	32.8
C-135	4.8	2.3
Various Modifications	1.4	0
Power Plant Changes	9.6	9.0
Miscellaneous Flight Safety	1.1	1.2
Common Avionics	1.1	1.2
Common ECM	19.2	24.0

Source: DON Justification of Estimates for Fiscal Year 1979. Submitted to Congress, January 1978.

for FY79 and FY80. The reader is again cautioned that these data contain costs which are not to be included in an O&S estimate.

Industrial Performance Summary for the Naval Air Rework Facilities provides data on the O&M cost of installing the modifications in a given fiscal year. Again, the problem arises that some costs are for conversion, upgraded capability or other reasons specifically excluded by the definition. The VAMOSC system also shows modification costs (procurement only) which are taken from NAVAIR Form 13050/2. Presumably, in the transcribing of this data some determination was made regarding the appropriateness, from an O&S standpoint, of each modification and it is possible to make a judgement regarding how much of the APN-5 modification funding is an O&S cost. VAMOSC for FY77 shows total modification procurement costs as being $312.5M. Total APN-5 modifications for the same year from the budget are $559.7M. Therefore, for FY77, 56% of the modification costs are O&S costs. Exhibit IV-5 provides a listing of the modification procurement costs from VAMOSC for a representative sample of aircraft. The analyst must remember that a large majority of these costs are identified only to type/model and that the VAMOSC system distributes these costs to the type/model/series based on flying hours. This procedure can be misleading.

For more information on the APN budget backup, contact the APN analyst in Op-92 (X-57408); for more information on the NARF summary, contact Ms. Barsky, NALC Code 210 (Au8-356-3952), and for more information on VAMOSC, contact CAPT Dowd, PMA 270 (X-27966).

EXHIBIT IV-5

Representative Modification Costs for FY77 from VAMOSC
($ in thous.)

Aircraft	Modification Costs Per A/C	Aircraft	Modification Costs Per A/C
A-3B	0	F-4B	18.8
EA-3B	0.4	F-4J	138.7
A-4E	6.3	F-4N	9.6
TA-4F	5.6	RF-8G	43.2
A-4F	6.1	F-14A	161.1
A-4M	116.9	F-5E	0
TA-4J	5.5	UH-1L	0.6
RA-5C	54.4	UH-1N	13.0
A-6A	1,132.7	SH2D/F	13.4
EA-6B	411.0	SH-3A	76.1
KA-6D	29.7	CH-46F	40.2
A-6E	65.4	CH-53D	122.4
A-7A	3.9	RH-53D	44.3
A-7E	59.9	P-3B	11.8
EC-121K	0	P-3C	17.4
C-130F	110.0	US-2A/B	0
C-1A	0	S-2E	0
C-2A	380.1	S-3A	54.2
E-1B	0	T-2C	0.1
E-2B	45.7	T-34	0
E-2C	278.1	OV-10	326.2
		AV-8A	10.8

21c. Cost-Estimating Relationship - The annual cost of aircraft modifications has been related to the flyaway costs with the following relationship:

$$M = 0.0041FC_{100}$$

where,

M = the annual cost of modifications (FY77$K)

FC_{100} = the cumulative average flyaway cost of the first 100 production aircraft (FY77$K)

21d. Alternative CER - Costs may be estimated by analogy using either VAMOSC or the APN budget backup as a basis.

21e. Example Calculation

Assume:

$$FC_{100} = 8{,}400 \text{ (FY77\$K)}$$

$$M = 0.0041 \times 8400$$

$$= 34.4 \text{ (FY77\$K)}$$

22. REPLENISHMENT GROUND SUPPORT EQUIPMENT

22a. Definition - This is the cost of replacement of ground servicing equipment, maintenance and repair ship equipment, instruments and laboratory test equipment, and other miscellaneous items such as ground generators, jet engine test stands, test sets for radios, radars, and fire control systems, hand tools, compressors, and gauges. These equipment demands are generated by the need to replace common and peculiar ground support equipment that is worn out or destroyed.

22b. Discussion - These costs are currently not identified to t/m/s aircraft in the budget or in any other data system.

22c. Cost-Estimating Relationship - This cost has been related to the flyaway cost of the aircraft.

$$RGSE = 0.0025FC_{100}$$

where,

RGSE = the annual cost of replenishment ground support equipment (FY77$K)

FC_{100} = the cumulative average flyaway cost of the first 100 production aircraft (FY77$K)

22d. Alternative CER - None

22e. Example Calculation:

Assume:

$$FC_{100} = 8,400 \text{ (FY77\$K)}$$

$$RGSE = 0.0025 \times 8,400$$

$$= 21.0 \text{ (FY77\$K)}$$

23. TRAINING ORDNANCE

23a. Definition - This is the cost of all conventional expendables used in non-combat flight operations of squadron aircraft for the purpose of keeping aircrews proficient in weapons delivery techniques. It includes the cost of sonobuoys, pyrotechnics, ballistic and guided weapons, as well as all conventional ordnance. Since many of these items, most notably the guided missiles, are considered weapon systems by themselves, it is easy to become confused regarding the definition of this element. An air-launched missile, for instance, has a complete set of O&S cost elements which are analyzed during its acquisition phase. None of these are to be included in this definition - only the procurement cost of the expended missile.

A second problem also arises which is the cost of air combat simulation at the Advanced Combat Maneuvering Range (ACMR). This is a program managed by Mr. Crangle, NAVAIR 630 (X2784), where Navy attack and fighter pilot training is being accomplished through the use of simulated dogfights, etc. in a heavily instrumented air space. The actual flying situation can then be recreated in a classroom environment and the pilots can discuss and improve their weapons delivery techniques which they exhibited in the flying exercise. Although this cost is a training cost for the pilot, it is not included in aircraft O&S costs since it is considered an O&S cost of the missile system. If more information is desired on the ACMR, contact Mr. Crangle or refer to the missile O&S guide.[1]

---

[1] Navy Air Launched Missile Operating and Support Cost Estimating Model, DRAFT, Administrative Sciences Corporation, July 1978.

23b. Discussion - Data on the expenditure of conventional ordnance is available from several sources, each with restrictions. The type commanders establish the requirements for the training ordnance necessary to attain combat readiness. Unit prices, which can be obtained from Ms. Goldberg, OP-411 (X-56582), had been recently obtained by Mr. Anding, of OP-96D, and are shown in Table C-8. Table C-8 also contains representative ordnance costs for three types of aircraft. The analyst is cautioned that these costs are for illustration purposes only and should be reconfirmed for each analysis.

Practically speaking, the requirements which are drawn up by the type commanders are significantly larger than what is permitted after the fiscal constraints have been imposed. In addition to fiscal constraints, war reserve stockpile considerations, future acquisition plans, and other factors affect actual expenditures.

The cost of actual expenditures of conventional ordnance are collected by the Conventional Ammunition Integrated Management System (CAIMS) which is operated by the Navy Ship Parts Control Center (SPCC), Mechanicsburg, PA. The CAIMS data is fed into the VAMOSC system and is the basis for the training expendables costs shown in the VAMOSC-TSS. The VAMOSC data has many problems, however, which make it extremely unreliable. The two major problems with the data are that they are heavily dependent on an allocation scheme and they omit two major components, sonobuoys and missiles.

23c. Cost-Estimating Relationship - No CER is given since training ordnance costs are not related to the physical characteristics or reliability and maintainability parameters which have been used throughout the model. The analyst must determine the weaponry installed or carried by the aircraft and then refer to Table C-8 for representative annual allowances and unit costs.

23d. Alternative CER - None

23e. Example Calculation - Assume the aircraft carries the same weaponry as the A-7 except the AIM-9 is replaced by the AMRAAM missile. Use one-half the attack requirements from Table C-8, Appendix C and add the one AMRAAM/pilot/yr.

	1 Requirements (from Table C-8)	(½ Column 1)*	Unit Price FY77$ (from Table C-8)	Total
MK76PB	325	162	12	1,944
MK106PB	30	15	8	120
MK82LDGP	12	6	1,024	6,144
MK82INERT	10	5	711	3,555
MK83LDGP	1	0	1,807	——
MK83INERT	1	0	1,141	——
MK45PARAFLARE	16	8	216	1,728
CHAFF RR129	175	87	2	174
MK46DECOY	8	4	23	92
20MM M55TP	2,250	1,125	2	2,250
AMRAAM		1	79,600	79,600
AGM45SHR	.7	.35	26,200	9,170
WALLEYE	1	.5	66,000	33,000
MK70 ROCKEYE II	1	0	3,310	——
MK52/55 MINE	4	2	16,850	33,700
				99,837

Cost per pilot = 99.8 (FY77$K)

Cost per AC = Cost per pilot x crew factor

= 99.8 x 1.42 (from Element 1)

= 141.7 (FY77$K)

---

*All quantities are rounded down. Fractional missiles are computed as such.

EXHIBIT IV-6

EXAMPLE SUMMARY

	Avg. Annual Cost Per Aircraft (FY77$K)
Deployed Unit Operations	
1. Aircrew (Officers)	31.4
2. Aircrew (Enlisted)	0
3. Combat Command Staff	14.9
4. Aviation POL	95.1
5. Other Deployed Manpower	23.9
6. Air TAD	2.3
Below Depot Maintenance	
7. Aircraft Maintenance Manpower	118.7
8. Maintenance Material	47.8
9. Personnel Support Supplies	3.0
Installation Support	
10. Base Operating Support	11.3
Depot Maintenance	
11. Component Rework	37.1
12. Airframe Rework	40.3
13. Engine Rework	49.9
Depot Supply	
14. Depot Supply Operations	11.4
15. Technical Support	42.8
Second Destination Transportation	
16. Second Destination Transportation	26.4
Personnel Support and Training	
17. Individual Training	26.8
18. Health Care	14.1
19. Personnel Activities	22.8
Sustaining Investments	
20. Replenishment Spares	21.2
21. Modifications	34.4
22. Replenishment Ground Support Equipment	21.0
23. Training Ordnance	141.7
Total Annual O&S Cost Per Aircraft	839.2

V. COMPUTATION OF LIFE CYCLE OPERATING AND SUPPORT COSTS

The term "life cycle operating cost" is defined to be the sum of all variable costs (as defined in Section II and discussed in Section IV) incurred from operating and supporting a weapon system over a specified time frame. The cost buildup begins when the first production aircraft enters the active/reserve force structure either as squadron equipment or combat crew training equipment.[1] Costs are summed through the force buildup period until full operational UE aircraft complement is attained. The FY74 CAIG Guide[2] calls for costs to be summed for buildup plus ten years, but this causes at least two problems. The first is that build-up plus ten years is simply not representative of life cycle costs for some systems. The second problem is that this method does not address the effect of attrition and true costs are therefore significantly overstated. If, on the other hand, additional aircraft are purchased to maintain the desired operating inventory, the procurement section of the life cycle cost analysis should be revised to reflect the additional purchases. An alternative procedure which will compute the approximate number of aircraft operating years is as follows:

---

[1]It is important to note here that aircraft operated in a fleet readiness squadron (FRS) will have a different unit O&S cost from squadron aircraft. This results from the fact that FRS manning is significantly different from that of a fleet squadron as is the utilization of the aircraft. Since the estimating capability contained in this report is geared to the fleet aircraft, analysis of the cost deltas (other than manpower) of fleet vs. FRS aircraft are difficult to determine. The differences, however, are quite small when analyzing program costs and usually are not addressed in a CAIG/DSARC review.

[2]Operating and Support Cost Development Guide for Aircraft Systems, Cost Analysis Improvement Group, May 1974.

$$TAOY = \frac{IV}{(1+P)} \int_{o}^{T} e^{-at} dt$$

where,

TAOY = the total aircraft operating years

IV = the number of aircraft procured

P = the pipeline factor (the percentage of aircraft in the depot maintenance process)

a = the annual attrition rate

T = the service life of the aircraft

Total life cycle O&S costs can then be computed by multiplying the total aircraft operating years (TAOY) by the average annual cost per UE (the sum of elements 1-23 in Section IV).

APPENDIX A

TABLE A-1

NAVY COST ELEMENT STRUCTURE

- Deployed Unit Operations
  1. Aircrew (Officers)
  2. Aircrew (Enlisted)
  3. Combat Command Staff
  4. Aviation POL
  5. Other Deployed Manpower
  6. Air TAD
- Below Depot Maintenance
  7. Aircraft Maintenance Manpower
  8. Maintenance Material
  9. Personnel Support Supplies
- Installation Support
  10. Base Operating Support
- Depot Maintenance
  11. Component Rework
  12. Airframe Rework
  13. Engine Rework
- Depot Supply
  14. Depot Supply Operations
  15. Technical Support
- Second Destination Transportation
  16. Second Destination Transportation
- Personnel Support and Training
  17. Individual Training
  18. Health Care
  19. Personnel Activities
- Sustaining Investments
  20. Replenishment Spares
  21. Modifications
  22. Replenishment Ground Support Equipment
  23. Training Ordnance

NAVY COST ELEMENT STRUCTURE AND DEFINITIONS

Deployed Unit Operations

1. Aircrew (Officer) - This is the cost of paying officer personnel who operate the squadron aircraft. Although all pilots perform other duties in the squadron, such as maintenance supervision or squadron staff functions, their primary duty is considered to be that of aircrew and their full cost is shown in this element.

2. Aircrew (Enlisted) - This is the cost of paying enlisted personnel who perform as crewmembers for the aircraft.

3. Combat Command Staff - This element represents the pay of manpower necessary for management and supervision of squadron operations. Included in this element are:

- the Air Wing Commander and his staff allocated equally to each of the wing's aircraft deployed on the carrier,
- the squadron Administration Department[1],
- the squadron Operations Department[1],
- the squadron Executive and Executive Assistance Department[1],
- the squadron Safety Department[1],
- the squadron Photo Department[1] (if any), and
- any other personnel whose primary function places them in this cost element.

4. Aviation Petroleum, Oil and Lubricants (POL) - Aviation POL is the cost of petroleum, oil and lubricants (including fuel additives) consumed by aircraft in flight operations and maintenance.

---

[1]Aircrewmembers excepted.

5. Other Deployed Manpower - This is the cost of all squadron personnel who are of a support or administrative nature. It is essentially the remainder of the squadron personnel who are not costed in Elements 1. Aircrew (Officers), 2. Aircrew (Enlisted), 3. Combat Command Staff, or 7. Aircraft Maintenance Manpower.

6. Air Temporary Additional Duty - Air Temporary Additional Duty (TAD) is the cost of travel, lodging and incidental expenses incurred so that squadron personnel can receive training (usually maintenance-related).

Below Depot Maintenance

7. Aircraft Maintenance Manpower - This element consists of the cost of all manpower necessary to support the total preventive and corrective maintenance actions performed on the aircraft and its installed systems and equipments. This includes the squadron personnel who are assigned TAD to the Aircraft Intermediate Maintenance Department.

8. Maintenance Material - This is the cost of all maintenance supplies, whether acquired by the Navy Stock Fund (NSF) or any other method of funded purchase which are not repaired for reuse. The costs are incurred at both the organizational and intermediate levels.

9. Personnel Support Supplies - This is the cost of all non-maintenance items used by the squadron for aircraft operations. It relates primarily to the health, safety and welfare of the aircrew. Personnel Support Supplies differ from Maintenance Material in that they are non-maintenance items. Technically, what is reported under this heading are the following supplies:

- Flight clothing
- Personnel survival equipment
- Consumable airborne photographic supplies
- Nitrogen
- Lox (liquid oxygen) and aviator's breathing oxygen
- Cartons and dining packets used for flight rations
- Squadron administrative consumable supplies
- and other items.

Installation Support

10. Base Operating Support - This is the cost of base manpower and the operating funds necessary to provide the base services which support the squadron.

Depot Maintenance

11. Component Rework - This is the cost of reworking or repairing components of the aircraft and its associated support equipment. This maintenance, which generally involves greater technical capability and more extensive facilities than are available at base level, is usually performed at the Naval Air Rework Facilities (NARF) but can also be done by another service or by a contractor. When the work is done by another service or a contractor, the cost is usually shown as a fixed price amount. When it is done by the NARF, it consists of labor, material and overhead.

12. Airframe Rework - This is the cost including labor, material and overhaul of making periodic inspections, repairs and overhaul of the airframe to assure its material condition.

13. Engine Rework - This is the cost of repairing and overhauling aircraft engines at the Naval Air Rework Facilities or facilities of other services or contractors.

Depot Supply

14. Depot Supply Operations - This is the cost of manpower and material needed to buy, store, package, manage and control supplies, spares and repair parts used in operating and maintaining aircraft, aircraft components and support equipment. When a new aircraft is introduced into the force, spare parts are procured to sustain operations. These parts are introduced into the supply system and resources are expended to manage, store, distribute, package and crate both the spares inventory and other common supply items which support aircraft system personnel.

15. Technical Support - This is the cost of a number of programs usually managed centrally, which support aircraft operations. A partial list of these programs is given below:

- Contractor Engineering Technical Services (CETS)
- Navy Engineering Technical Services (NETS)
- Depot Rework of Ground Support Equipment (GSE)
- Installation and Calibration of GSE
- Depot Rework of Catapult and Arresting Gear
- Technical Publications Updates
- NAVAIRSYSCOM Representatives

Second Destination Transportation

16. Second Destination Transportation - This is the cost of shipping material needed to support the aircraft unit. Material includes: (1) spare and repair parts that are shipped between the centralized repair depots and the aircraft unit; and (2) support iems that are needed by aircraft unit personnel such as food and administrative supplies.

Personnel Support and Training

17. Individual Training - This is the cost of paying personnel in training who will replace unit personnel, the training staff and training operating funds. This includes all training from recruit training through undergraduate pilot and navigator training, as well as the operation and maintenance of trainers and simulators by the Fleet Aviation Specialized Operational Training Detachments (FASOTRADET's) and the Naval Air Maintenance Training Detachments (NAMTRADET's). This element does not include any aspect of readiness training, which is costed as a separate squadron.

18. Health Care - Health care is the cost of medical personnel and materials needed to provide medical support to aircraft unit personnel and to base personnel who provide direct support to the aircraft.

19. Personnel Support - Personnel support is comprised of two parts. The first part consists of the costs incident to the permanent change of station (PCS) of squadron and base operating personnel, either individually or as an organized unit. The second portion is the cost of recruiting and examining activities, the cost of transient personnel, and the cost of prisoners.

Sustaining Investments

20. Replenishment Spares - This is the cost of procuring aircraft assemblies, spares and repair parts which are normally repaired and returned to stock. In addition, it includes procurement of stock levels that are not provided by initial spares procurement.

21. Modifications - The cost of modifying aircraft, ground equipment, and training equipment to enable them to perform mission essential tasks (not new capability), and to improve reliability or reduce maintenance cost.

This includes the cost of purchasing the modifications including the requisite engineering plus the cost of depot installation. There are no installation costs involved at the organizational and intermediate levels since those personnel are dedicated to support of the aircraft and their time is included in the other cost elements.

22. Replenishment Ground Support Equipment - This is the cost of replacement of ground servicing equipment, maintenance and repair ship equipment, instruments and laboratory test equipment, and other miscellaneous items such as ground generators, jet engine test stands, test sets for radios, radars, and fire control systems, hand tools, compressors, and gauges. These equipment demands are generated by the need to replace common and peculiar ground support equipment that is worn out or destroyed.

23. Training Ordnance - This is the cost of all conventional expendables used in non-combat flight operations of squadron aircraft for the purpose of keeping aircrews proficient in weapons delivery techniques. It includes the cost of sonobuoys, pyrotechnics, ballistic and guided weapons, as well as all conventional ordnance.

APPENDIX B

OFFICE OF THE SECRETARY OF DEFENSE
WASHINGTON, D. C. 20301

August 31, 1977

MEMORANDUM FOR THE COST ANALYSIS IMPROVEMENT GROUP (CAIG) AND
VAMOSC TASK FORCE

SUBJECT: Weapon System Operating and Support Cost Element Structures and Definitions

As you know, we have been working with the Services and the OSD staff for some time to develop CAIG operating and support costing structures for selected weapon classes.

Enclosed are aircraft, ship, combat vehicle and air-launched tactical missile cost element structures and definitions. The aircraft structure represents a modification to the structure contained in the May 1974 CAIG O&S cost development guide for aircraft systems. The ship, combat vehicle and tactical missile structures have not been previously issued.

Effective immediately, these new structures will be used when preparing and submitting O&S cost estimates of these weapon classes to the CAIG/DSARC and as the basis for collecting O&S cost data under DOD's VAMOSC Task.

Our current schedule calls for issuing a revised CAIG aircraft guide this fall; ship, combat vehicle and missile guides will follow early next year. These new guides will contain the enclosed cost structures and incorporate many of the analysis provisions and reporting formats contained in the "Guidelines for Analysis" developed for the CAIG by the Logistics Management Institute (LMI). Particular attention should be paid to: the System Program Definition Statement; the requirement for a pre-CAIG meeting to determine the groundrules for the O&S cost analysis to be conducted for the DSARC/CAIG; and the maintenance sizing methodology.

I recommend a thorough review of the LMI guidelines now as a preview of forthcoming CAIG/DSARC and OSD weapon systems analysis requirements. If you have not received copies of the LMI reports, please contact Frank Swofford at extension 52612.

Finally, I ask that Service CAIG representatives distribute the new cost structures to their respective system command and program manager organizations. It is important to obtain future PM cost estimates in a form consistent with those prepared by the independent cost teams.

Frank W. Scofield
for Milton A. Margolis
Chairman
OSD Cost Analysis Improvement Group

Enclosures (4)

AIRCRAFT OPERATING AND SUPPORT COST ELEMENT STRUCTURE

301 Deployed Unit Operations
- 301.1 Aircrews
- 301.2 Command Staff
- 301.3 POL
- 301.4 Security
- 301.5 Other Deployed Manpower
- 301.6 Personnel Support

302 Below Depot Maintenance
- 302.1 Aircraft Maintenance Manpower
- 302.2 Ordnance Maintenance Manpower
- 302.3 Maintenance Materiel
- 302.4 Personnel Support

303 Installations Support
- 303.1 Base Operating Support
- 303.2 Real Property Maintenance
- 303.3 Personnel Support

304 Depot Maintenance
- 304.1 Manpower
- 304.2 Materiel

305 Depot Supply
- 305.1 Materiel Distribution
- 305.2 Materiel Management
- 305.3 Technical Support

306 Second Destination Transportation

307 Personnel Support and Training
- 307.1 Individual Training
- 307.2 Health Care
- 307.3 Personnel Activities
- 307.4 Personnel Support

308 Sustaining Investments
- 308.1 Replenishment Spares
- 308.2 Modifications
- 308.3 Replenishment Ground Support Equipment
- 308.4 Training Ordnance
  - 308.4.1 Munitions
  - 308.4.2 Missiles
  - 308.4.3 Sonobuoys

300 OPERATING AND SUPPORT: The variable cost of operating and supporting a weapon system including contractual support.

301 DEPLOYED UNIT OPERATIONS:[1] The cost of deployed unit manpower (for example, crews, command staff and security personnel); POL; and other operating expenses chargeable to the non-maintenance activities of a deployed unit including contractual support. A deployed unit consists of any unit operating in the field for combat, training or other operating purpose.

301.1 Aircrews: The cost of paying the full complement of aircrews required to man unit aircraft. Included are all aircrew personnel necessary to meet: combat deployment requirements; training requirements; and administrative requirements such as leave.

301.2 Command Staff: The cost of paying the personnel required for unit flying supervision. These personnel perform such jobs as command, operations control, planning and scheduling, flying safety, quality control on aircrew training and flying proficiency and include the combat commander, the squadron commanders and their respective staffs.

301.3 POL: The cost of aviation petroleum, oil and lubricants required for peacetime unit flying operations, including allowances for distribution, storage and spillage.

301.4 Security: The cost of paying personnel needed for unit aircraft equipment security: For example, entry control, close and distant boundary support, and security alert teams.

301.5 Other Deployed Manpower: The cost of paying all other personnel (for example, public information and social action people) assigned to a typical deployed unit during peacetime, except those personnel included in cost elements 301.1 (Aircrews), 301.2 (Command Staff), and 302 (Below Depot Maintenance).

301.6 Personnel Support: The cost of supplies, services and equipment needed to support deployed unit personnel. Examples of included costs are admini strative supply items; travel expenses; expendable - office machines and equipment; custodial services; and other variable personnel-oriented support costs incurred at the deployed unit.

302 BELOW DEPOT MAINTENANCE:[2] The cost of manpower and materiel needed for maintenance of deployed unit aircraft, support equipment and ordnance including contractual spport.

302.1 Aircraft Maintenance Manpower: The cost of paying the personnel needed to meet below depot maintenance requirements (including contractor support) of the deployed unit. Included are personnel needed to meet the maintenance demands of the assigned aircraft and aircraft support equipment; precision measurement equipment laboratory equipment; and training similators and support equipment: to provide for maintenance supervision and control: and to cover administrative requirements such as leave.

302.2 Ordnance Maintenance Manpower: The cost of paying the personnel needed for: loading, unloading, arming and dearming of munitions and missiles; inspection, testing and maintenance of all aircraft weapons release systems; maintenance, ammunition loading, activation and deactivation of aircraft gun systems; and maintenance and handling of the munitions and missile stockpile authorized by the WRM plan.

302.3 Maintenance Materiel: The cost of purchasing materiel from the General and System Support Divisions of the Stock Fund. This includes only non-reparable expense items consumed in the repair process. Excludes reparables procured from the Stock Fund which are included in cost element 308.1 (Replenishment Spares).

302.4 Personnel Support: The cost of supplies, services and equipment needed to support below-depot maintenance personnel. Examples of included costs are administrative supply items; travel expenses; expendable office machines and equipment; custodial services; and other variable personnel-oriented support costs incurred at the maintenance activities.

303 INSTALLATION SUPPORT: The variable cost of providing support for deployed unit personnel at the unit's support installation(s). Includes contractual support.

303.1 Base Operating Support: The cost of installation personnel and materiel necessary to directly support the deployed unit. Examples of installation functions which directly support the unit include food service, supply and motor pool operations. There personnel and costs would no longer be incurred by the installation if the deployed unit were moved elsewhere.

303.2 Real Property Maintenance: The variable costs of construction, maintenance and operation of real property facilities, and related management and engineering support work and services.

303.3 Personnel Support: The cost of supplies, services and equipment needed to support installation support personnel. Examples of included costs are administrative supply items; travel expenses; expendable office machines and equipment; custodial services; and other variable personnel-oriented support costs incurred at the installation(s).

304 DEPOT MAINTENANCE: The cost of manpower and materiel needed to perform aircraft and aircraft component and support equipment maintenance at DoD centralized repair depots (including contractual support) and contractor repair facilities.

304.1 Manpower: The cost of labor needed to perform major overhaul; repair; modification; inspection; and storage and disposal of aircraft and aircraft components and support equipment. Includes variable overhead for organic repair.

304.2 Materiel: The cost of materiel consumed in the depot overnaul, repair, inspection and storage and disposal process.

305 DEPOT SUPPLY: The cost of manpower and materiel needed to buy, store, package, manage and control the supplies, spares and repair parts used in operating and maintaining aircraft and aircraft components and support equipment; and to provide sustaining (service) engineering and technical data support for aircraft systems. Includes contractual support.

305.1 Materiel Distribution: The cost of manpower and materiel needed to fill requisitions for supplies, spares and repair parts. Included are receiving, unpacking, storage, inspection and packing and crating costs.

305.2 Materiel Management:[3] The cost of manpower and materiel needed to manage the procurement of supplies, spares and repair parts and maintain control and accountability of these assets.

305.3 Technical Support: The cost of sustaining (service) engineering and technical data and documents needed to perform sustaining engineering and maintenance on aircraft components and support equipment.

306 SECOND DESTINATION TRANSPORTATION: The round trip cost of transporting engines and engine components, ground support equipment and reparable secondary items to depot maintenance facilities and back to the operational unit or CONUS stock points and the one-way cost of transporting repair parts from CONUS stock points to depot and below-depot maintenance activities.

307 PERSONNEL TRAINING AND SUPPORT: The variable cost of initial and replacement training (training pipeline), moving and health care of personnel. Includes contractual support.

307.1 Individual Training:[4] The variable cost of recruit, technical (skill), undergraduate pilot and undergraduate navigator training includes:

- the pay of training pipeline personnel
- the cost of their instruction (including instructor pay)

307.2 Health Care: The variable cost of providing medical support to deployed unit, below-depot maintenance, installation support and training pipeline personnel including:

- the pay of medical personnel who provide this support
- the cost of medical materiel

307.3 Personnel Activities: The PCS costs of: deployed unit, below-depot maintenance, installation support, training pipeline and medical personnel.

307.4 Personnel Support: The cost of supplies, services and equipment needed to support training pipeline and medical personnel. Examples of included costs are administrative supply items; travel expenses; expendable office equipment and machines; custodial services; and other variable personnel-oriented support costs incurred at training centers and medical facilities.

308 SUSTAINING INVESTMENTS: The cost of procuring spares, modification kits and materiel, ground support equipment and training ordnance needed to sustain deployed unit peacetime operations. Exclude WRM costs.

308.1 Replenishment Spares: The cost of procuring aircraft assemblies, spares and repair parts which are normally repaired and returned to stock. In addition, this cost can include procurement of stock levels that are not provided by initial spares procurement.

308.2 Modification Kits and Materiel: The cost of modifying aircraft, ground equipment, and training equipment that are in the operating inventory to make them safe for continued operation, to enable them to perform mission essential tasks (not new capability), and to improve reliability or reduce maintenance cost. Includes spares for modified equipment.

308.3 Replenishment Ground Support Equipment (GSE): The cost of replenishing common ground servicing equipment, maintenance and repair shop equipment, instruments and laboratory test equipment, and other equipment including spares for these equipments. Covers such items as ground generators; jet engine stands; test sets for radios, radars and fire control systems; hand tools; compressors; gauges and other minor items. These equipment demands are generated by a need to: (1) replace peculiar support equipment bought using aircraft procurement funds; (2) obtain common off-the-shelf ground equipment that are needed to support aircraft operations as production aircraft arrive in the operating inventory; and (3) replenish common ground equipment that is no longer useable.

308.4 Training Ordnance: The cost of replacing or increasing stocks of training ammunition, bombs, rockets, missiles, and sonobuoys expended during peacetime flying operations.

308.4.1 Munitions: The cost of munitions (live and inert) expended by the operating unit for the purpose of sustaining aircrew proficiency in weapon's delivery techniques.

308.4.2 Missiles: The cost of missiles (live and inert) expended by the operating unit for the purpose of sustaining aircrew proficiency in weapon's delivery techniques.

308.4.3 Sonobuoys: The cost of sonobuoys used during peacetime.

NOTES:

[1]If the unit operates weapon systems in addition to the type being evaluated, create a typical unit to represent the manpower and expenses required for deployment of the aircraft of interest and explain how the costs were derived.

[2]In the Army, below depot maintenance includes all manpower authorized in aviation unit maintenance (AVUM) and aviation intermediate maintenance (AVIM) units. Manpower in units which support more than one type aircraft should be estimated on the basis of relative workload. In the Navy, below depot maintenance includes all manpower authorized in the squadron maintenance department, the Air TAD (temporary additional duty) and an estimated share, based on relative workloads, of the manpower of the aviation intermediate maintenance department of an aircraft carrier or air station. In the Air Force, below depot maintenance includes manpower authorized in the wing for the chief of maintenance, quality control, maintenance control, and aircrew life support sections; those authorized in the organizational field and avionics maintenance squadrons; and those assigned in the munitions maintenance squadron.

[3]Include contractor logistic support costs for the appropriate aircraft system.

[4]Factory training provided by contractors at their facilities to qualify an initial cadre of skilled personnel to: (1) operate and maintain a weapon system when operationally deployed or (2) initially man Services weapon system-related training courses, is paid for by both investment and O&M funds. Contractor instructor pay and the cost of instruction at contractor facilities is categorized as an investment cost; the pay of Service military and civilian personnel attending the factory schools is an O&S cost.

APPENDIX C

TABLE C-1

NAVY COMPOSITE STANDARD MILITARY RATE TABLE
(Effective 1 October 1977)

Pay Grade	Rank or Grade	Hourly Rate	Daily Rate	Monthly Rate	Annual Rate
0-10	Admiral	$26.41	$211.24	$4,577	$54,923
0-9	Vice Admiral	24.77	198.17	4,294	51,524
0-8	Rear Admiral (Upper Half)	23.49	187.91	4,071	48,857
0-7	Rear Admiral (Lower Half)	19.92	159.35	3,453	41,430
0-6	Captain	18.45	147.62	3,198	38,381
0-5	Commander	15.41	123.25	2,670	32,045
0-4	Lieutenant Commander	12.93	103.41	2,241	26,886
0-3	Lieutenant	11.38	91.03	1,972	23,667
0-2	Lieutenant Junior Grade	8.51	68.07	1,475	17,698
0-1	Ensign	6.20	49.58	1,074	12,891
W-4	Commissioned Warrant Officer	12.04	96.29	2,086	25,036
W-3	Commissioned Warrant Officer	9.59	76.29	1,662	19,939
W-2	Commissioned Warrant Officer	8.31	66.45	1,440	17,277
W-1	Warrant Officer	7.57	60.57	1,312	15,748
E-9	Master Chief Petty Officer	10.11	80.84	1,752	21,019
E-8	Senior Chief Petty Officer	8.69	69.50	1,506	18,070
E-7	Chief Petty Officer	7.53	60.20	1,304	15,652
E-6	Petty Officer First Class	6.37	50.99	1,105	13,258
E-5	Petty Officer Second Class	5.26	42.04	911	10,930
E-4	Petty Officer Third Class	4.42	35.38	767	9,199
E-3	Seaman	3.87	30.99	671	8,057
E-2	Apprentice	3.55	28.40	615	7,384
E-1	Recruit	3.18	25.47	552	6,621
	Midshipmen	2.62	20.98	455	5,456

Source: NAVCOMPT Notice 7041, 13 December 1977.

TABLE C-2

[illegible] (REV. 3-76)
[illegible] OF NAVAL OPERATIONS
[illegible]

MANPOWER AUTHORIZATION

FOR DETAILED DESCRIPTION OF ENTRIES, REFER TO OPNAVINST [illegible]

[illegible]	[illegible]
91337	[illegible]

[illegible] CODE	ACTIVITY NAME	PROGRAM ELEMENT CODE	UIC	S/S	[illegible]	[illegible]	MANPOWER CLAIMANT	GEOGRAPHIC LOCATION [illegible]
[illegible]-00	COM CVW 7	24652N	00736		DW	10	CINCLANTFL	VIRGINIA, VIRGINIA BCH OCEANA
		2	7	8	9	10	11	12

	BILLET TITLE (19 A)	20	21	22	23	24	25	26	27	28	BILLETS AUTH (29)	S/R (30)	M+1 (31)	M+2 (32)	M+3 (33)	M+6 (34)	M+12 (35)	FY 78 (36)	FY 79 (37)	FY 80 (38)	FY 82	[illegible]
OVERALL BASIC TOTALS											10	5	15	15	15	15	15	10	10	10	10	[illegible]
OVERALL BASIC/AUGMENT TOTALS											10	5	15	15	15	15	15	10	10	10	10	[illegible]

DISTRIBUTION
[illegible] ORIGINAL COM CVW 7
[illegible] COMNAVAIRLANT
[illegible]
[illegible]
[illegible]
[illegible] OP-121C3

CURRENT ALLOWANCE TOTALS BY PAY GRADE

PROGRAM ELEMENT 24652N

	FLAG	CAPT	CDR	LCDR	LT	LTJG	ENS	CWO-4	CWO-3	CWO-2	WO-1	TOTALS
BASIC			1	5	4							10
SUBTOTAL			1	5	4							10
TOTAL			1	5	4							10

TABLE C-2 (cont'd.)

[illegible] (REV. 9 76)
FROM: CHIEF OF NAVAL OPERATIONS
TO: DISTRIBUTION LIST

MANPOWER AUTHORIZATION

FOR DETAILED DESCRIPTION OF ENTRIES, REFER TO OPNAVINST. 1000.16 (SERIES)

TRANS [illegible] 91537 — 09/01/7[illegible]

ACTIVITY CODE	ACTIVITY NAME	PROGRAM ELEMENT CODE	UIC	S/S	MGA	[illegible]	MANPOWER CLAIMANT	GEOGRAPHIC LOCATION/HOMEPORT
1 06 1 2336-0007-00	COM CVW 7	24652N	09736		DW	10	CINCLANTFL	VIRGINIA, VIRGINIA BCH OCEAN[illegible]
4	5	6	7	8	9	10	11	12

THE FOLLOWING IS A SUMMARY OF THE ORGANIZATIONAL BILLETS ABOVE

BILLET TITLE (19/19A)	DESIGNATOR RATE (26)	27	BILLETS AUTH (29)	S/R (30)	M+1 (31)	M+2 (32)	M+3 (33)	M+6 (34)	M+12 (35)	FY 78 (36)	FY 79 (37)	FY 81	FY 82
	1302H	Q	1		1	1	1	1	1	1	1	1	1
	1302I		1		1	1	1	1	1	1	1	1	1
	1302J		1		1	1	1	1	1	1	1	1	1
1300 TOTALS			3		3	3	3	3	3	3	3	3	3
	1311K			2	2	2	2	2	2				
	1312I		1		1	1	1	1	1	1	1	1	1
	1312I	Q	1		1	1	1	1	1	1	1	1	1
1310 TOTALS			2	2	4	4	4	4	4	2	2	2	2
	1321J			1	1	1	1	1	1				
	1321K			1	1	1	1	1	1				
1320 TOTALS				2	2	2	2	2	2				
	1520I		1		1	1	1	1	1	1	1	1	1
1520 TOTALS			1		1	1	1	1	1	1	1	1	1
	1630J	P	1		1	1	1	1	1	1	1	1	1
	1630K			1	1	1	1	1	1				
1630 TOTALS			1	1	2	2	2	2	2	1	1	1	1
	2102I		1		1	1	1	1	1	1	1	1	1
	2102J		1		1	1	1	1	1	1	1	1	1
2100 TOTALS			2		2	2	2	2	2	2	2	2	2
	6360J		1		1	1	1	1	1	1	1	1	1
6360 TOTALS			1		1	1	1	1	1	1	1	1	1

LAST PAGE

TABLE C-2 (cont'd.)

OPNAV ... (REV. 9-76)
FROM: CHIEF OF NAVAL OPERATIONS
TO: DISTRIBUTION LIST

MANPOWER AUTHORIZATION

FOR DETAILED DESCRIPTION OF ENTRIES, REFER TO OPNAVINST. 1000.16 (SERIES)

TRANS 0153 ... 09/01/7...

ACTIVITY CODE	ACTIVITY NAME	PROGRAM ELEMENT CODE	UIC	S/S	AMC MGR	CLAIM CODE	MANPOWER CLAIMANT	GEOGRAPHIC LOCATION HOMEPORT
1 0 1 3006-0067-00	COM CVW 7	24652N	09736		DW	10	CINCLANTFL	VIRGINIA, VIRGINIA BCH OC...
3 4	5	6	7	8	9	10	11	12

BILLET TITLE (19)	19A	BSC (20)	ADD'L QUAL (21/22)	PRIM NOBC NEC (23)	SEC NOBC NEC (24)	DESIGNATOR RATE (25)	26/27	EFF DATE MO/YR (28)	BILLETS AUTH (29)	S/R (30)	M+1 (31)	M+2 (32)	M+3 (33)	M+6 (34)	M+12 (35)	FY 78 (36)	FY 79 (37)		
00100 ... OP FOR COM		99	DGO/E	9005		1302H	O		1		1	1	1	1	1	1	1	1	1
00200 OPS/ELX WRFR AV		99	DGO/E	8685	9632	1312I	O		1		1	1	1	1	1	1	1	1	1
00300 ASW OPS OFF	4046H	99	DG1/E	8685	8515	1312I			1		1	1	1	1	1	1	1	1	1
00300 ADMINISTRATIVE OFF-ASST L		99	DB2/E	2615		1302J			1		1	1	1	1	1	1	1	1	1
00... SAFETY OFFICE-LSO/ADDU TO VA-12 OR VA-66		99	DA4/E	8662		1302I			1		1	1	1	1	1	1	1	1	1
00500 LANDING SIGNAL		99	DGO/E	8662		1311K				2	2	2	2	2	2				
00... AIR INTELLIGENCE		99		9680		1630J	P		1		1	1	1	1	1	1	1	1	1
00... ASST AIO		99		9680		1630K				1	1	1	1	1	1				
00... WING/GROUP MNT		99		8180		1520I			1		1	1	1	1	1	1	1	1	1
00... DATA ANALYST		99	D23/E	2642		1321K				1	1	1	1	1	1				
00... AVIONICS		99	DGO/E	8199		1321J				1	1	1	1	1	1				
00... ORDNANCE/NUCLEAR SAFETY		99		9296		6960J			1		1	1	1	1	1	1	1	1	1
01000 FLIGHT SURGEON/ATTACK		99	CAF/	0045		2102I			1		1	1	1	1	1	1	1	1	1
01100 FLIGHT SURGEON/FIGHTER		99	CAF/	0045		2102J			1		1	1	1	1	1	1	1	1	1
TOTAL BILLETS PROJECTIONS									10	5	15	15	15	15	15	10	10	10	10

144

TABLE C-3

MANPOWER AUTHORIZATION

FOR DETAILED DESCRIPTION OF ENTRIES, REFER TO OPNAVINST, 1000.16 (SERIES)

(REV. 9-76)
FROM CHIEF OF NAVAL OPERATIONS
TO DISTRIBUTION LIST

TRANS NUMBER: 0722 | DATE: 10-13-78

ACTIVITY CODE	ACTIVITY NAME	PROGRAM ELEMENT CODE	UIC	S/S	AMD	TYCOM CODE	MANPOWER CLAIMANT	GEOGRAPHIC LOCATION/HOMEPORT				
1 06 1 2236-0007-00	COM C W 7	24652N	0073	2	L	10	CINCLANTFLT	VIRGINIA VIRGINIA BCH OCEANA	053A	00	07	
3 4	5	6	7	8	9	10	11	12	13	14	15	16

BILLET TITLE	SUBSPECIALTY CODES	BOC	ACQ SPE CAT	U PRI MAN	PRIM NOBC NEC	SEC NOBC/ ADD NEC	DESIG/GR RATE		FAC	EFF DATE MO YR	BILLETS AUTH	S/R	M+1	M+2	M+3	M+6	M+12	FY 79	FY 80	FY 81	FY 82	FY 83	FY 84
19	19 A	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41

ORGANIZATIONAL MANNING (cols. 30–35); REQUIREMENTS (cols. 36–41)

DISTRIBUTION
02-A00 ORIGINAL COM CVW 7
01-N11 COMNAVAIRLANT
01-E MAC NOLA
01-C INCLANTFLT
02-0 ICIATOR OP-121C3

	29	30	31	32	33	34	35	36	37	38	39	40	41
OVERALL BASE TOTALS	7		7	7	7	7	7	7	8	7	7	7	7
OVERALL BASE/AUGMENT TOTALS	7		7	7	7	7	7	7	8	7	7	7	7

CURRENT ALLOWANCE TOTALS BY PAY GRADE

PROGRAM ELEMENT 24652N

	MCPO	SCPO	CPO	PO1	PO2	PO3	PG-E3	PG-E2	PG-E1	TOTALS
BASE	2		2		1	1	1			7
SUBTOTAL	2		2		1	1	1			7
TOTAL	2		2		1	1	1			7

TABLE C-3 (cont'd.)

OPNAV 1000/2 (REV. 9-78)
FROM: CHIEF OF NAVAL OPERATIONS
TO: DISTRIBUTION LIST

MANPOWER AUTHORIZATION

FOR DETAILED DESCRIPTION OF ENTRIES, REFER TO OPNAVINST, 1000.16 (SERIES)

TRANS NUMBER	DATE (MO, DA, YR)
20728	10-13-78

ACTIVITY CODE	ACTIVITY NAME	PROGRAM ELEMENT CODE	UIC	S/S	AMC/MCA	PROGRAM CODE	MANPOWER CLAIMANT	GEOGRAPHIC LOCATION/HOMEPORT	
1 06 1 2136-0067-00	COM [illegible] W 7	24752N	09736	2	1	10	CINCLANTFLT	VIRGINIA VIRGINIA [illegible] OCEANA	053A 00 07
4	5	6	7	8	9	10	11	12	13 14 15 16

THE FOLLOWING IS A SUMMARY OF THE ORGANIZATIONAL BILLETS ABOVE

BILLET TITLE / SUBSPECIALITY CODES (19, 19A)	PRIM NOBC NEC (23)	DESIG/GR RATE (25)	EFF DATE MO YR (28)	BILLETS AUTH (29)	S/R (30)	M+1 (31)	M+2 (32)	M+3 (33)	M+6 (34)	M+12 (35)	FY 79 (36)	FY 80 (37)	FY 81 (38)	FY 82 (39)	FY 83 (40)	FY (41)
	0318	OSC										1				
			1079	1												
OS TOTALS												1				
		YNC		1		1	1	1	1	1	1	1	1	1	1	
		YN3		1		1	1	1	1	1	1	1	1	1	1	1
		YNSN		1		1	1	1	1	1	1	1	1	1	1	
YN TOTALS				3		3	3	3	3	3	3	3	3	3	3	3
		AVCM		1		1	1	1	1	1	1	1	1	1	1	
AV TOTALS				1		1	1	1	1	1	1	1	1	1	1	
		ADC		1		1	1	1	1	1	1	1	1	1	1	
AD TOTALS				1		1	1	1	1	1	1	1	1	1	1	
		AOCM		1		1	1	1	1	1	1	1	1	1	1	
AO TOTALS				1		1	1	1	1	1	1	1	1	1	1	
	6313	AZ2		1		1	1	1	1	1	1	1	1	1	1	1
AZ TOTALS				1		1	1	1	1	1	1	1	1	1	1	1
PROJECTIONS			1079	1												
NET PROJECTIONS				1												

LAST PAGE

TABLE C-3 (cont'd.)

OPNAV 1000/3 (REV. 9-76)
FROM: CHIEF OF NAVAL OPERATIONS
TO: DISTRIBUTION LIST

MANPOWER AUTHORIZATION

FOR DETAILED DESCRIPTION OF ENTRIES, REFER TO OPNAVINST, 1000.16 (SERIES)

TRANS NUMBER: 0756 | DATE (YR, MO, DA): 10 19 78

MA	ACTIVITY CODE	ACTIVITY NAME	PROGRAM ELEMENT CODE	UIC	S/S	APC MCN	TYCOM CODE	MANPOWER CLAIMANT	GEOGRAPHIC LOCATION/HOMEPORT	DES	MA	DA
1	05 1 0336-0007-00	COM C A T	34 52N	09220	2	L	10	CINCLANTFLT	VIRGINIA VIRGINIA BCH OCEANA	053A	00	07
	4	5	6	7	8	9	10	11	12	13	14	15 16

BILLET SEQ NO	BILLET TITLE / SUBSPECIALITY CODES	BOC	ADD SPE CAT	ADD U FR MAN	PRIM AQDC/ NEC	SEC NOBC/ ADD NEC	DESIG/GR RATE	FAC	EFF DATE MO	EFF DATE YR	BILLETS AUTH	ORGANIZATIONAL MANNING S/R	M+1	M+2	M+3	M+6	M+12	REQUIREMENTS FY 79	FY 80	FY 81	FY 82	FY 83	FY
18	19 / 19A	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41
00100	OFFICE SUPVR	99					YNC				1		1	1	1	1	1	1	1	1	1	1	
00200	CORRES CLERK	99					YN3				1		1	1	1	1	1	1	1	1	1	1	
00300	CORRES CLERK	99					YN3N				1		1	1	1	1	1	1	1	1	1	1	
00400	JOINT COORD	99					AVCM				1		1	1	1	1	1	1	1	1	1	1	
00500	ASST JOINT COORD	99					ADC				1		1	1	1	1	1	1	1	1	1	1	
00600	ATA ANALYST	99			6313		AT2				1		1	1	1	1	1	1	1	1	1	1	
00800	CPO	99					AQCM				1		1	1	1	1	1	1	1	1	1	1	
01800	AIR INTERCEPT CONTROLLER	99			0319		OSC												1				
01900										1079	1												
	TOTAL BILLETS										7		7	7	7	7	7	7	8	7	7	7	
	PROJECTIONS										1												

Table C-4

Engine Removal Data

Period: Jan.-Dec.1977

Engine	No. of Engines Removed at IMA	Sent to Depot			%
		Policy	Cause	Total	
F402	25	0	18	18	72
J34	14	0	7	7	50
J48	1	0	0	0	0
J52	1,358	56	432	488	36
J57	123	3	66	69	56
J60	91	2	23	25	27
J65	6	0	6	6	100
J79	562	47	258	305	54
J85	498	6	85	91	18
TF30	631	68	304	372	59
TF34	194	6	105	111	57
TF41	487	85	293	378	78
T400	136	2	29	31	23
T53	83	2	13	15	18
T56	624	5	271	276	44
T58	1,130	75	265	340	30
T64	217	37	81	118	54
T76	77	1	20	21	27
TOTAL	6,257	395	2,276	2,671	43

Table C-5

Engine Removal Data

Period: Jan.-March 1978

Engine	No. of Engines Removed at IMA	Sent to Depot			%
		Policy	Cause	Total	
F402	8	0	6	6	75
J34	2	0	0	0	0
J52	292	17	94	111	38
J57	20	3	14	17	85
J60	21	2	2	4	19
J79	151	16	70	86	57
J85	145	8	26	34	23
TF30	159	21	83	104	65
TF34	60	7	17	24	40
TF41	140	16	75	91	65
T400	51	7	20	27	53
T53	19	2	4	6	32
T56	153	1	57	58	38
T58	286	20	80	100	35
T64	41	10	19	29	71
T76	21	2	13	15	71
TOTAL	1,569	132	580	712	45

February 20, 1973
NUMBER 4140.40

ASD(I&L)

Department of Defense Directive

SUBJECT Basic Objectives and Policies on Provisioning of End Items of Materiel

Refs: (a) DoD Directive 4100.35, "Development of Integrated Logistic Support for Systems and Equipment," October 1, 1970
(b) DoD Instruction 4151.7, "Uniform Technical Documentation for Use in Provisioning of End Items of Materiel," January 29, 1961
(c) DoD Instruction 4100.38, "Provisioning and Other Pre-procurement Screening," September 9, 1968
(d) DoD Instruction 4140.19, "Phased Provisioning of Selected Items for Initial Support of Weapons Systems, Support Systems and End Items of Equipment, May 1, 1968
(e) DoD Directive 4130.2, "The Federal Catalog System Within the Department of Defense," July 22, 1971
(f) DoD Instruction 5100.63, "Provisioning Relationships Between the Military Services/Defense Agencies and Commodity Integrated Materiel Managers," June 7, 1972
(g) Joint Regulation AR 700-82/OPNAVINST 4410.2/AFR 66-45/ MCO 4400.120/DSAR 4100.6, "Joint Regulation Governing the Use and Application of Uniform Source Maintenance & Recoverability Codes," June 27,1971 (see VIII.below)
(h) DoD Instruction 3232.4, "Policy and Principles Governing Provisioning of End Items of Materiel," April 2, 1956 (hereby cancelled)
(i) DoD Instruction 3232.5, "Department of Defense Source, Maintenance and Recoverability Codes," November 27, 1956 (hereby cancelled).

I. PURPOSE

This Directive sets forth basic objectives and policies governing the provisioning for initial support of end items of materiel acquired by contract from commercial/industrial sources. In consonance with the concepts and objectives of reference (a), this Directive is intended to promote

effective, efficient, and timely provisioning for initial support by and among the using Military Services, the Defense Agencies, and their industry suppliers, and with the General Services Administration.

II. APPLICABILITY AND SCOPE

This Directive is applicable to the Military Departments, Defense Nuclear Agency, Defense Supply Agency, and National Security Agency (hereinafter referred to as DoD Components), in the planning, programming, selection, and acquisition of items for the initial support of end items of materiel. The scope of this Directive encompasses all end items of materiel acquired by DoD Components for which a DoD maintenance capability (i.e., servicing, repair, and overhaul) is anticipated. Provisioning for initial support of end items furnished under grant aid or military sales programs will be accomplished as indicated in the applicable portions of the Military Assistance and Sales Manual (MASM).

III. EXPLANATION OF PROVISIONING AND DEFINITIONS

The explanation and definitions contained in Enclosure 1 are applicable to this Directive. The definitions will be adopted for use in all implementing regulations, instructions, and orders issued by DoD Components.

IV. OBJECTIVES

A. The principal objective of provisioning is to assure the timely availability of minimum initial stocks of support items at using organizations and at maintenance and supply activities to sustain the programmed operation of end items until normal replenishment can be effected, and to provide this support at the least initial investment cost.

B. Supporting objectives in furtherance of the principal objective, stated above, include the following:

1. To develop uniform technical documentation requirements for use by DoD Components and contractors in the provisioning process (reference (b)).

2. To develop DoD standards and specifications for use in contracts which prescribe uniform provisioning procedures between and among the DoD Components and contractors.

3. To assign uniform codes for management purposes to support items during provisioning.

4. To initiate provisioning planning early in the life cycle of developing hardware programs, as required by Integrated Logistics Support (reference (a)).

5. To screen manufacturers' part numbers and other reference number data during the provisioning process so as to prevent unnecessary or duplicate items from entering the supply system (reference (c)).

6. To make maximum use of existing DoD assets in lieu of procurement.

7. To compute initial requirements for support items using: (a) latest end item program or delivery data, (b) actual failure and/or test data wherever available in lieu of engineering estimates unless there are compelling reasons to the contrary, and (c) minimum operating levels and repair and overhaul pipeline quantities that are consistent with the ability of the maintenance and supply systems to respond with replenishment support.

8. To take calculated risks during the initial support period by deferring procurement of partial quantities of computed requirements for selected support items whenever operating program uncertainties or other special circumstances make such risks acceptable in the context of available resources.

9. To program the use of contractors' in-production capabilities to assist in initial supply support through the application of phased provisioning techniques (reference (d)) and such other management techniques as may be developed to reduce initial investment costs (paragraph IV. A. above).

10. To program sufficient time into the provisioning process to perform cataloging operations incident to having support items received at maintenance and supply activities with Federal/National Stock Numbers (FSN/NSN) (reference (e)).

11. To fully coordinate among using DoD Components the provisioning plans, decisions, and support for multiservice-use end items.

V. POLICIES

A. The using DoD Component has the responsibility for the final determination of the range and quantity of support items required for the initial outfitting/lay-in of new end items entering the operating inventory. The determination of the range and quantities of support items to be stocked in the wholesale supply system, including range and quantity recommendations for items assigned to integrated materiel managers (reference (f)), is also the responsibility of the using DoD Component. These responsibilities may be delegated to another DoD Component by written mutual consent, but will not be delegated to a contractor. Exception: For long-leadtime support items and other support items urgently needed because of approved design changes having early effective dates, the procuring DoD Component may authorize contractors to interim release limited quantities of support items to production in advance of formal approval. The interim released quantity so authorized will not exceed six months' anticipated usage or a compressed repair pipeline quantity (expedited handling and repair), and will be subject to early post-approval by the DoD Component. Notwithstanding the above, contractors may be requested to furnish recommendations on range and quantity of support items required, including requisite test data and estimated failure rate data.

B. A support item will not be procured through the provisioning process when provisioning screening (reference (c)) reveals that the item or an acceptable substitute item is already an established item (i.e., assigned an FSN/NSN), and the item is managed by a DoD Component other than the provisioning DoD Component. Initial outfitting/lay-in requirements will be provided by means of a Supply Support Request (SSR) placed with the DoD Component managing the item (reference (f)). When the established item is currently managed by the provisioning DoD Component, the item will not be procured through the provisioning process after the demand development period for the item has been completed. The requirements for the item will be filled from existing stocks or through normal replenishment procurement.

C. The Integrated Logistic Support Plan developed in accordance with the policy concepts of reference (a) will be the foundation upon which provisioning planning and programming will be developed.

D. The Integrated Logistic Support Plan for major acquisition programs will provide for the most cost-effective logistics

support posture.

1. When contractor/vendor support is determined to be cost-effective for selected support items during the early production period, DoD Components will specify the contractor support terms in the initial production contract. These terms will designate selected support items for contractor support through an initial support period. Selected items are those with poor reliability/unstable design, of high risk and high unit cost which require sizeable initial investment, and for which the probability of design obsolescence or expensive modification is most likely. The using Service normally will provide only for a remove and replace maintenance capability at the operational site for those selected items; the contractor/vendor will perform the repair of the unserviceable items, including the furnishing of spares and repair parts and associated tools and test equipment by utilizing his in-production inventories and capabilities.

2. When design stability can be realistically projected (i.e., leadtime in advance of anticipated design validation through subsystems test programs) for each item under contractor/vendor support, the using DoD Component will normally program the item for phase-over to organic support. Until this phase-over, the contract terms will specify that the contractor/vendor will own, or otherwise provide for, and operate his maintenance and supply capability, including his investment in the selected support items required for replacement of unserviceable items. As phase-over to organic support occurs, the contractor/vendor assets normally will be procured to the extent needed to fill initial support requirements. It is of utmost importance that (a) specific contract terms be developed and cited in the original production contract; (b) the using DoD Component retain the right to designate the selected items; (c) least-cost decisions be applied on use of contractor/vendor expedited handling and repair versus initial investment cost in support items; (d) contractor/vendor costs for this support be separately identified and monitored; and (e) phase-over to organic support be programmed as a follow-on action to the provisioning process so that an orderly transition will result.

E. Provisioning actions and decisions will be scheduled in advance of the end item delivery in such a manner that timely delivery of items is accomplished for initial support. On complex end item programs a method of incremental release of procurement orders for support items will be followed so that the commitment/obligation of funds will be made based on the procurement leadtime of the support items away from the scheduled initial outfitting/lay-in support dates. When it is determined to be uneconomical to incrementally release orders, this policy may be waived by the procuring DoD Component.

F. Initial outfitting/lay-in quantities of support items will be scheduled for delivery to using organizations in advance of the initial operational date of the end item to allow time for local inventory and warehousing operations. This time will not exceed 30 days for high cost items or 90 days for low cost items. Exception to this policy is the added time required to install, test, and check out end item equipments, and to install specialized tools, test and support equipment and train personnel in their use.

G. For end item acquisition programs involving two or more using DoD Components, the procuring DoD Component will be responsible for assuring that a single set of DoD standards and specifications, including uniform provisioning technical documentation requirements, are cited in contracts. The procuring agent also will be responsible for obtaining prior agreements on fully coordinated provisioning operations by the using DoD Components in such a manner that unnecessary duplication of data, formats, procedures and operations is avoided.

H. The uniform Source, Maintenance, and Recoverability (SM&R) codes of the Joint Regulation (reference (g)) will be the only SM&R codes assigned during the provisioning of new end items.

1. The using DoD Component has the responsibility for the assignment of the uniform SM&R codes. For multiservice used end items, coding decisions will be coordinated among the using DoD Components to promote maximum practical interservice maintenance and supply support.

2. Previously used SM&R codes assigned to support items for end items already in the operating inventory need not be converted to the uniform SM&R codes.

I. Commercially available end items will not be provisioned without first validating a need for on-hand inventories of support items in lieu of reliance on commercial sources for support. When adequate support of commercial end items can be reasonably assured through direct/local procurement of support items from commercial off-the-shelf inventories or through commercial servicing, procurement of support items through the provisioning process will be avoided. Normally, end items procured in small quantities (i.e., ten or less), for use only within the U. S., with low anticipated hours or occasions of usage and/or for non-critical operations, are candidates for support from commercial sources. When a limited on-hand supply of support items is considered necessary, consideration also will be given to the issue of a one-time repair kit with the end item, with any resupply to be obtained

from the DoD Supply System for stocked items, and to be obtained through direct/local procurement by the organizational user for non-stocked items.

J. Provisioning technical documentation requirements (reference (b)) will be kept to the minimum consistent with the needs to: (1) perform SM&R coding (reference (g)), (2) provisioning screening (reference (c)), (3) compute outfitting/lay-in requirements and wholesale system stocks of spares and repair parts, (4) select and compute requirements for special tools, test equipment, and support equipment, (5) conduct item entry control, (6) prepare Federal Catalog data (reference (e)), and (7) procure for initial support.

K. Inventory assets of support items (on hand and on order) will be considered applicable assets in the computation of net provisioning requirements. Government owned assets in the custody of contractors for support of end items used in development and test programs and during initial introductory operations will be considered applicable assets in that period of time they become available.

L. Insurance items will be procured only in minimum quantities. Very high cost insurance items (exceeding $10,000 unit cost) will not be initially acquired; procurement will be deferred until production phase-out of the end item, or until a demand occurs. Exceptions to this policy will be permitted only on an item-by-item basis by Departmental or Agency level approval of specific overriding considerations.

M. Procurement of special tools, test equipment, and support equipment will be limited to authorized allowances. For end items procured in low quantities and requiring a proportionately high investment cost in special tools and equipments, full consideration will be given to contractor maintenance support in lieu of organic depot support.

N. On a selective basis and with full documentation confirming the economic justification, production phase-out procurement for life of operating programs may be authorized at the end of the production run for those support items where it is economically impractical to reestablish a limited production capability.

O. War reserve/mobilization stocks of support items will not be procured during the early introduction phase of new end items into the operating inventory. Such stocks may be procured and positioned with an end item only at the time the end item is assigned to a major military mission.

P. When the service life of a support item is expected to be increased through a component improvement program or through other advances in design or manufacturing of the item, the computation of provisioning requirements for the item will anticipate the projected increased service life.

VI. RESPONSIBILITIES

A. The ASD(I&L) is assigned overall policy administration and implementation of the provisioning process by the DoD Components. This assignment includes the development and issuance of specific policies and procedures, and criteria for the determination of requirements within the scope of this Directive.

B. The Department of the Navy will be responsible for the maintenance, coordination, and publication of the Joint Regulation (reference (g)) and subsequent changes or amendments thereof.

VII. CANCELLATION

References (h) and (i) are hereby superseded and cancelled.

VIII. EFFECTIVE DATE AND IMPLEMENTATION

This Directive is effective immediately. Two (2) copies of each implementing document prepared by DoD Components will be furnished to the ASD(I&L) within 120 days. Two (2) copies of any proposed changes or amendments to the Joint Regulation (reference (g)), will also be furnished to the ASD(I&L) for approval prior to publication.

W. P. Clements

Deputy Secretary of Defense

Enclosure 1
Explanation of Provisioning and Definitions

EXPLANATION OF PROVISIONING AND DEFINITIONS

A. The process of provisioning is an essential and critically timed series of actions required to assure initial support for end items entering the operating inventory of the Armed Forces. Planning for provisioning normally begins early in the life cycle of new end items of military design or prior to procurement of commercially designed end items. Planning for provisioning is required to assure that appropriate documents (i.e., standards and specifications) are cited in production (and preproduction) contracts. To be fully effective, provisioning must be a cooperative series of scheduled events between the customer (military user) and the contractor (industry supplier). To this end DoD Components, under the Department of Defense policies and guidance as contained in references (a), (b), (c), (d), (e), and (f), have developed and implemented a set of provisioning procedural documents.

B. Provisioning is a process or series of actions extending over a wide range of functions, including design, maintenance planning, supply, requirements determination, item entry control, procurement, cataloging, and contract administration. The effect of design changes on previously provisioned items is monitored throughout the production period of end item contracts. In instances where modification programs for end items occur beyond the production period, provisioning is accomplished to assure adequate initial support for the modified end items. Provisioning culminates in the delivery of a minimum range and quantity of support items for initial outfitting/lay-in at user activities, bases or ships and for maintenance/supply activities for support during an initial period of service.

C. The following definitions assist in a better understanding of the provisioning process and are to be used in all implementing regulations, instructions, and orders issued by DoD Components:

1. Provisioning. A management process for determining and acquiring the range and quantity of support items necessary to operate and maintain an end item of materiel for an initial period of service.

   a. The provisioning process begins at the time a production contract is awarded for an end item of materiel, and continues through the period of time required to have support items shipped by manufacturers and suppliers.

   b. Initial provisioning (the first-time provisioning for a new end item), follow-on provisioning (a subsequent provisioning of the same end item from the same contractor) and reprovisioning (a subsequent provisioning of the same end item from a different contractor) are specific types of provisioning.

c. Provisioning normally does not include the acquisition of support items for replenishment purposes or to augment existing stocks of items already established in the wholesale supply system.

2. Provisioning for Initial Support. The provisioning of the (a) initial outfitting/lay-in quantities of support items and (b) wholesale supply system quantities including repair/overhaul cycle quantities of support items required to sustain the operational support of in-service end items until such time as normal replenishment deliveries can be accomplished.

3. Initial Outfitting/Lay-In. The positioning of support items at user levels and at intermediate supply and maintenance levels as initial issues in anticipated support of newly deployed end items; excludes wholesale supply system stocks.

4. End Items. A final combination of end products, component parts, and/or materials which is ready for its intended use; e.g., ship, tank, mobile machine shop, aircraft.

5. Support Items. Items subordinate to, or associated with, an end item (i.e., spares, repair parts, tools, test equipment, support equipment, and sundry materials) and required to operate, service, repair or overhaul an end item.

6. Spares. Those support items that are coded to be repairable (i.e., Reparable Items).

7. Repair Parts. Those support items that are coded to be not repairable (i.e., Consumable Items).

8. Tools and Test Equipment. Those support items that are not an integral part of an end item but are required to inspect, test, calibrate, service, repair or overhaul an end item.

9. Support Equipment. Those support items that are not an integral part of an end item but are required in the operation of the end item.

10. Special Tools, Test Equipment, and Support Equipment. Those support items that have single/peculiar application to a specific end item.

11. Management Coding. The assignment of codes consisting of letters and/or numerals to support items to record management decisions, such as sources for resupply, prescribed levels of maintenance, item managers, and other management data

HEADQUARTERS NAVAL MATERIAL COMMAND
WASHINGTON D.C. 20360

IN REPLY REFER TO
013/ES
1026 160
17 NOV 1976

TABLE C-7

From: Chief of Naval Material
To: Commander, Naval Supply Systems Command

Subj: Budgeting for Follow-On Outfitting (FOO) Requirements

1. Effective with the Fiscal Year 1978 apportionment budget submission, all FOO Appropriation Purchases Account (APA) requirements are to be budgeted for as replenishment requirements. Only requirements applicable to first time provisioning of new items will be budgeted for on the initial budget line. This policy is to be applicable regardless of whether an item is in or out of the Demand Development Period (DDP).

2. FOO requirements are to be entered into the files as time phased Planned Program Requirements (PPRs) to be considered in normal replenishment computations a lead time in advance of the due date, and replenishment funds used to finance any resulting procurement.

3. FOO PPRs are to be aggregately listed on each applicable cog stratification to budget transition statement and a separate clearly defined line item listing by quantity and dollar value provided as budget back up. This listing will be used to prorate, by cog, applicable budget constraints and/or budget marks. Budget execution would conform to the assessed constraints.

4. It is requested that NAVSUP coordinate a SYSCOM/ICP effort to establish procedures required to implement the above policy. An interim progress report is to be provided CHNAVMAT (MAT-01) by 30 November 1976.

Murray C. Cook

MURRAY C. COOK
Deputy Chief of Naval Material
(Programs and Financial Management)

Copy to:
CNO (OP-412)
NAVAIR
NAVSEA
NAVELEX
SSPO
SPCC
ASO

TABLE C-8

REPRESENTATIVE ANNUAL TRAINING ORDNANCE COST
(FY77$)

Ordnance	Unit Cost	Annual Cost Per Crew		
		Attack	Fighter	ASW
MK 76 PB	12	3,900	504	1,857
MK 106 PB	8	240	—	—
MK 82 LDGP	1,024	12,288	8,192	—
MK 82 INERT	711	7,110	11,376	—
MK 83 LDGP	1,807	1,807	—	—
MK 83 INERT	1,141	1,141	—	—
MK 45 PARAFLARES	216	4,320	4,320	—
CHAFF RR 129	2	350	234	—
MK 46 DECOY	23	184	230	—
M 55 TP	2	7,000	7,000	—
AIM-9L/M	45,000	—	22,500	—
AIM-7F	75,000	37,500	24,750	—
AMRAAM	85,000	—	—	—
MK 20 ROCKEYEII	3,536	3,536	—	—
MK 52/55	18,000	—	—	—
MK 82 LGB	5,000	20,000	—	—
AGM 45 SHR	28,000	14,000	—	—
WALLEYE I/II	70,000	—	—	—
AN/SSQ 41	172	—	—	13,722
AN/SSQ 53	498	—	—	14,954
AN/SSQ 50	482	—	—	19,296
SN/SSQ 62	691	—	—	20,743
AN/SSQ 47	482	—	—	19,296
AN/SSQ 36	155	—	—	1,554
		113,376	79,106	91,422

TABLE C-9

FY77 COST DATA (FY77$)

Aircraft	1 POL/FH (POLF)	2 Maint. Supt. (MS)	3 Per.Sup. Supt. (PSS)	4 Other Oper. Cons. (OOC)	5 Comp. RW (CRF)	6 Repl.Sprs. (RS)	7 Airframe RW Unit (UAR)
A-4M	226.2	297.7	5.7	303.4	100	12.8	—
RA-5C	525.8	432.1	39.1	471.2	535	78.4	506.7
EA-613	383.6	282.8	12.0	294.8	218	19.8	176.0
A-6E	399.8	264.7	9.2	273.9	41.7	27.0	191.3
A-7E	242.4	121.4	4.8	126.3	167	15.9	92.1
C-1A	51.0	98.8	7.2	105.9	45	4.6	47.4
C-2A	176.9	210.5	6.9	217.5	166	91.4	209.8
C-117D	63.5	98.8	7.7	106.5	58	4.4	78.3
C-118B	207.8	144.4	7.6	152.0	32	4.9	—
C-130F	278.1	111.3	5.2	116.4	68	6.7	260.9
E-2B	151.4	179.5	10.2	189.7	370	41.9	426.2
E-2C	148.2	176.0	11.7	187.6	435	48.2	254.5
F-4J	566.2	220.5	11.0	231.6	334	25.4	196.8
F-14N	574.7	278.0	10.0	288.0	193	33.5	250.7
RF-8G	282.7	245.7	50.6	296.3	272	26.4	356.8
F-14A	469.7	374.0	13.0	387.0	416	34.5	409.4
UH-1N	25.7	86.4	4.8	91.1	18	1.2	67.0
SH-2F	47.9	113.8	17.8	126.6	126	14.1	70.6
SH-3A	55.8	110.7	7.4	118.1	102	21.5	104.8
SH-3D	59.0	95.3	7.0	102.3	216	29.3	109.0
SH-3G	56.5	156.2	10.4	166.7	174	11.2	118.2
SH-3H	60.3	82.3	9.8	92.2	212	10.8	108.6
HH-46A	56.7	165.6	16.5	182.1	329	23.4	70.8
CH-46D	56.3	140.8	14.1	154.9	226	40.0	74.6
CH-46F	40.9	1060.5	7.0	1067.5	299	33.4	82.8
P-3A	276.8	222.2	10.4	232.6	42	10.7	264.9

TABLE C-9 (cont'd.)

FY77 COST DATA (FY77$)

Aircraft	1 POL/FH (POLF)	2 Maint.Supt. (MS)	3 Per.Sup. Supt. (PSS)	4 Other Oper. Cons. (OOC)	5 Comp. RW (CRF)	6 Repl.Sprs. (RS)	7 Airframe RW Unit (UAR)
P-3B	281.1	105.7	7.0	113.7	242	14.2	261.1
P-3C	281.8	115.3	10.0	125.3	240	7.7	207.9
US-2B	45.7	108.6	6.0	114.6	61	3.7	40.2
S-3A	150.4	203.6	13.8	217.4	397	10.4	—
T-28B	19.3	110.9	3.5	114.3	19	3.6	—

TABLE C-9 (cont'd.)

FY77 COST DATA

Engine	Number Overhauled	Unit Cost (FY77$K)	Number Repaired	Unit Cost (FY77$K)
J52-P8B	120	47.1	150	20.2
J52-P408	9	49.5	82	19.0
J57-P10	3	78.3	45	11.6
J79-GE8	1	60.9	103	26.6
J79-GE10	6	57.3	321	28.4
TF30-P408	6	148.4	37	33.0
TF30-P412A	19	140.7	166	37.7
J85-GE4A	9	27.1	24	16.4
TF41-A2	40	79.0	328	30.0

TABLE C-10

FY77 EXPLANATORY VARIABLES

Aircraft	Max Speed Knots (MS)	MMH/FH	MMH/MO MMO	Gross Take-off Wt. (thous. of lbs.) (GT)
A-4M	515	18.7	479	11.1
RA-5C	1,164	87.8	2,420	36.3
EA-6B	538	50.7	1,768	26.6
A-6E	563	47.4	1,227	26.6
A-7E	606	28.4	920	19.1
C-1A	230	15.4	579	13.6
C-2A	306	34.1	1,216	24.7
C-117D	—	24.7	612	—
C-118B	—	35.8	709	—
C-130F	326	16.7	1,302	70.3
E-2B	320	39.0	1,358	23.5
E-2C	320	27.4	1,092	23.5
F-4J	1,280	47.7	1,120	24.8
F-14N	1,491	47.1	906	24.8
RF-8G	1,174	49.1	1,214	13.6
F-14A	1,342	54.2	1,135	32.7
UH-1N	110	13.0	433	4.3
SH-2F	143	25.8	801	6.0
SH-3A	144	32.5	1,394	9.3
SH-3D	144	25.0	972	9.3
SH-3G	144	27.7	878	9.3
SH-3H	144	22.2	780	9.3
HH-46A	139	22.3	421	10.4
CH-46D	139	21.0	579	10.4
CH-46F	144	65.5	1,499	10.4
P-3A	409	20.3	1,070	61.2
P-3B	409	21.2	1,361	61.2
P-3C	409	19.3	1,134	61.2
US-2B	230	18.3	344	13.2
S-3A	432	28.8	955	19.3
T-28B	304	20.7	272	—

APPENDIX D

USER INSTRUCTIONS

1. Introduction

The aircraft model is operated at the Op-96D offices utilizing NCSS VP/CSS, a terminal oriented, dial-up system. It is written in Fortran IV and stored in file[1] AIRMODEL FORTRAN. File definitions and loading statements are stored in file AIRMODEL EXEC. In order to execute the model, one must access the system through an approved user name and password, and type AIRMODEL fn_1 fn_2, where fn_1 and fn_2 are the file names to be used by the model for data input.

fn_1 may be either T (for Terminal) or the name[2] of a pre-stored file. Initial input entries must be via fn_1.

fn_2 is optional. If no entry is made, all changes and/or thruput entries are assumed to be via fn_1 otherwise, fn_2 may be either T or the name[2] of a pre-stored file.
If fn_2 is present, all changes and/or thruput for the model execution, as well as any subsequent iterations of the model must be made via fn_2.
If either fn_1 or fn_2 is specified as T, the model will instruct the user to enter the appropriate data as needed. Otherwise no comments will be made by the model during the input phase.

---

[1]In the VP/CSS system all files have three identifiers; filename, filetype, and filemode. If omitted, the filemode defaults to P. All files used in connection with this model are filemode P.

[2]For the input files of this model, two filetype names have been reserved. AIRINP is the filetype associated with fn_1 and AIRTHRU is the filetype associated with fn_2.

2. Input

Whether input directly through the terminal or via a pre-stored file, the input values are entered in the same format, which is as follows:

Name

P_1, P_2,.....P_{23}

AC_1, AC_2,.....AC_n

Name is a run descriptor (8 character maximum) and P_1 thru P_{23} are parametric values in the order listed in Table E-1. AC_1 is the number of aircraft in year 1, AC_2 is the number of aircraft in year 2, and AC_n is the number of aircraft in year n, where n represents the number of years being computed in this run. The value of n is contained in P_4. P_1 thru P_{23} may utilize as many lines as required, as may AC_1 thru AC_n; however, both P_1 and AC_1 must start a line. Since P_5 provides the capability of entering a constant number of aircraft for each year, AC_1 thru AC_n are not always required.

Aircraft input requirements are determined as follows:

if $P_4 = 0$, no life cycle costs are computed;

if $P_4 = n \neq 0$ and $P_5 = 0$, a variable stream of aircraft per year, AC_1.....AC_n, is required;

if $P_4 = n \neq 0$ and $P_5 = m$, no aircraft stream is input, since a constant stream, AC_i.....AC_n, is computed such that all $AC_i = m$.

Changes to Input - Should the user desire to test the results of variations in the basic input, a capability for revising any of the values has been included.

TABLE -1

REQUIRED INPUT

INDEX	DESCRIPTION
1	MPN RATE (OFF)
2	MPN RATE (ENL)
3	STARTING FY
4	# OF YEARS
5	# A/C PER YR(EACH)
6	CCS OFFICERS
7	CCS ENLISTED
8	OFF CREW ALLOW
9	ENL CREW ALLOW
10	MAINT MHR/MO
11	FLYING HRS/MO
12	AIR TAD (000$)
13	GROSS T/O (000LBS)
14	MAX SPEED(ALT KTS)
15	EMPTY WT (000LBS)
16	THRUST/ENG(000LBS)
17	DEP ENG A R (HRS)
18	OVHL/REPAIR RATIO
19	ENG TYP(0JET 1FAN)
20	# OF ENGINES
21	A/C RW CYCLE (MOS)
22	FLYAWAY COST (MIL)
23	TRNG ORDN (THOUS)
24	MTBF (HRS)
25	AVIONICS DUMMY 0/1

The change format is as follows:

i, P_i

: :

j, P_j

0, 0

i, AC_i

: :

j, AC_j

0, 0

where,

i,j = index numbers

P_i, P_j = revised values for the i^{th} and j^{th} parameters

AC_i, AC_j = revised values for the i^{th} and j^{th} years

and 0, 0 terminates each set of changes. Each change pair must be entered on a separate line.

Thruput - In some instances annual costs may be known for a specified element. Therefore, a capability for entering average annual costs directly has been provided. Should any other element cost be dependent on the item selected for thruput, that cost will be computed from the thruput cost. The thruput format is as follows:

i, e_i

: :

j, e_j

0, 0

where,

i,j = element index numbers (see Table E-2)

e_i, e_j = thruput values for the i^{th} and j^{th} average annualcost

and 0,0 terminates the set of thruputs.

3. Model Execution

Input Print Options - Prior to the execution of the model, the user has the option of printing the input to be used, in one of two formats.

a. The program queries the user with DESCRIBE INPUT?, and the user responds with Y or N. If the user answers Y, an input parameter table (Table E-3), and a computed value table (Table E-4), complete with index, value and descriptive text are printed. Next, the string of AC_i values for the required number of years is printed and the model queries the user OK TO GO?. If the user responds Y, the model is executed. If the user responds N and the terminal input mode is in effect, the user will again be instructed to enter changes and thruput as described in preceeding paragraphs. If the terminal input mode is not in effect, the run will terminate and the user must make the required file changes.

b. If the user answered N to DESCRIBE INPUT?, the program query PRINT INPUT? is displayed. If the user responds Y, the input parameter values and the computed values, devoid of descriptive text, and the string of AC values are printed and the program proceeds exactly as described above. The OK TO GO? interrogatory is included to give the user an opportunity to review and confirm input, thruput, and computed values before lengthy output is printed.

TABLE -2

COST ELEMENTS STRUCTURE WITH INDEX NUMBERS

OPERATING AND SUPPORT COST

INDEX	ELEMENTS
1	DEPLOYED UNIT OPS
2	AIRCREWS(OFFICERS)
3	AIRCREWS(ENLISTED)
4	COMBAT COMMAND STF
5	POL
6	OTHER DEPLOYED MPN
7	AIR TAD
8	BELOW-DEPOT MAINT
9	A/C MAINT MPN
10	MAINTENANCE MAT'L
11	PERS SUP SUPPLIES
12	INSTALLATIONS SUP
13	BASE OPS SUPPORT
14	O&M BASE OPS
15	MPN BASE OPS
16	DEPOT MAINTENANCE
17	COMPONENT REWORK
18	AIRFRAME REWORK
19	ENGINE REWORK
20	DEPOT SUPPLY
21	DEPOT SUPPLY OPS
22	TECHNICAL SUPPORT
23	2ND DEST TRANS
24	2ND DEST TRANS

TABLE -2 (cont'd.)

COST ELEMENTS STRUCTURE WITH INDEX NUMBERS

25	PERS SUP & TRAIN
26	INDIVIDUAL TRAIN
27	O&M
28	MPN
29	HEALTH CARE
30	O&M
31	MPN
32	PERS ACTIVITIES
33	O&M
34	MPN
35	SUS INVESTMENTS
36	REPLEN SPARES
37	MODIFICATIONS
38	REPLEN GSE
39	TRAINING ORDNANCE

TABLE -3

INPUT PARAMETER TABLE

COMPUTED

INDEX	DESCRIPTION
1	A/C MAINT MPWR
2	OTHER DEPL MPWR
3	TOTAL DIR OFF MPWR
4	TOTAL DIR ENL MPWR
5	INDIRECT OFF MPWR
6	INDIRECT ENL MPWR
7	POL ($/FH)
8	MM & PSS ($/FH)
9	COMP REW ($/FH)
10	A/C REW (000$/REW)
11	ENG OVH (000$/ENG)
12	ENG REP (000$/ENG)
13	ENG COST ($/FH)
14	REPL SP ($/FH)

TABLE -4

COMPUTED VALUES

```
   DESCRIBE INPUT ?
>Y

    SAMPLE

    INDEX          DESCRIPTION

        1          MPN RATE (OFF)
        2          MPN RATE (ENL)
        3          STARTING FY
        4          # OF YEARS
        5          # A/C PER YR
        6          CCS OFFICERS
        7          CCS ENLISTED
        8          OFF CREW ALLOWANCE
        9          ENL CREW ALLOWANCE
       10          MAINT MHR/MO
       11          FLYING HRS/MO
       12          AIR TAD (000$)
       13          GROSS T/O WT(000LBS)
       14          MAX SPEED(ALT KTS)
       15          EMPTY WT (000LBS)
       16          THRUST/ENG(000LBS)
       17          DEP ENG ARR RT (HRS)
       18          OVHL/REPAIR RATIO
       19          ENG TYP(0JET 1FAN)
       20          # OF ENGINES
       21          A/C RW CYCLE (MOS)
       22          FLYAWAY COST (MIL)
       23          TRNG ORDN (THOUS)
       24          MEAN TIME-B-F (HRS)
       25          AVIONICS DUMMY (0,1)
```

Computation - The model then computes average annual cost per UE, for each element, the total program cost for each element for each specified year, and costs by appropriation.

4. Output

Output is printed at the end of each execution of the model. The average annual cost per UE, by element and by appropriation is displayed in the first column. Subsequent columns provide total program costs by year in the same CES. Sample output is provided in Appendix D.

5. Iteration

At the conclusion of each output set, the program queries the user with MORE?. If the user responds with N, the program terminates. If the user responds with Y, the program is ready to accept further variations on input and produce another set of results.

APPENDIX E

SAMPLE RUNS

STORED FILE FOR RUN

```
PRINTF SAMPLE AIRINP

SAMPLE
22.141 9.517 1980 10 1
.18 1.15 1.42 0 600 30 2.3 45 600 20 16 400 .25 1 1 36 8.4 141.7 1 0
```

STORED FILE INPUT

```
15.38.50 >AIRMODEL SAMPLE T
DISK FILE ASSUMED
EXECUTION:



          ENTER PARAMETER CHANGES (INDEX,VALUE)
                                    DELIMITOR = 0,0
>0,0

          ENTER THRUPUT VALUES (INDEX,VALUE)
                                    DELIMITOR = 0,0
>0,0
```

DESCRIBE INPUT ?
>Y

SAMPLE

INDEX	VALUE	DESCRIPTION
1	22.14	MPN RATE (OFF)
2	9.52	MPN RATE (ENL)
3	1980.00	STARTING FY
4	10.00	# OF YEARS
5	1.00	# A/C PER YR
6	0.18	CCS OFFICERS
7	1.15	CCS ENLISTED
8	1.42	OFF CREW ALLOWANCE
9	0.0	ENL CREW ALLOWANCE
10	600.00	MAINT MHR/MO
11	30.00	FLYING HRS/MO
12	2.30	AIR TAD (000$)
13	45.00	GROSS T/O WT(000LBS)
14	600.00	MAX SPEED(ALT KTS)
15	20.00	EMPTY WT (000LBS)
16	16.00	THRUST/ENG(000LBS)
17	400.00	DEP ENG ARR RT (NRS)
18	0.25	OVHL/REPAIR RATIO
19	1.00	ENG TYP(0JET 1FAN)
20	1.00	# OF ENGINES
21	36.00	A/C RW CYCLE (MOS)
22	8.40	FLYAWAY COST (MIL)
23	141.70	TRNG ORDN (THOUS)
24	1.00	MEAN TIME-B-F (HRS)
25	0.0	AVIONICS DUMMY (0,1)

COMPUTED

INDEX	VALUE	DESCRIPTION
1	12.48	A/C MAINT MPWR
2	2.51	OTHER DEPL MPWR
3	1.60	TOTAL DIR OFF MPWR
4	16.14	TOTAL DIR ENL MPWR
5	1.52	INDIRECT OFF MPWR
6	16.44	INDIRECT ENL MPWR
7	264.08	POL ($/FH)
8	141.16	MM & PSS ($/FH)
9	103.05	COMP REW ($/FH)
10	120.75	A/C REW (000$/REW)
11	143.38	ENG OVH (000$/ENG)
12	33.46	ENG REP (000$/ENG)
13	138.61	ENG COST ($/FH)
14	58.86	REPL SP ($/FH)

AC PER YR	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

OK TO GO ?
>Y

SAMPLE OPERATING AND SUPPORT COST ESTIMATE
(THOUSANDS OF FY77$)

	AVERAGE ANNUAL COST PER UE	TOTAL COST 10 AC
TOTAL	839	8266
DEPLOYED UNIT OPS	168	1677
AIRCREWS(OFFICERS)	31	314
AIRCREWS(ENLISTED)	0	0
COMBAT COMMAND STF	15	149
POL	95	951
OTHER DEPLOYED MPN	24	239
AIR TAD	2	23
BELOW-DEPOT MAINT	170	1695
A/C MAINT MPN	119	1187
MAINTENANCE MAT'L	48	478
PERS SUP SUPPLIES	3	30
INSTALLATIONS SUP	11	113
BASE OPS SUPPORT	11	113
O&M BASE OPS	8	79
MPN BASE OPS	3	34
DEPOT MAINTENANCE	127	1152
COMPONENT REWORK	37	371
AIRFRAME REWORK	40	282
ENGINE REWORK	50	499
DEPOT SUPPLY	54	542
DEPOT SUPPLY OPS	11	114
TECHNICAL SUPPORT	43	428
2ND DEST TRANS	26	265
2ND DEST TRANS	26	265
PERS SUP & TRAIN	64	640
INDIVIDUL TRAIN	27	268
O&M	5	52
MPN	22	216
HEALTH CARE	14	141
O&M	7	68
MPN	7	73
PERS ACTIVITIES	23	231
O&M	1	10
MPN	22	220
SUS INVESTMENTS	218	2183
REPLEN SPARES	21	212
MODIFICATIONS	34	344
REPLEN GSE	21	210
TRAINING ORDNANCE	142	1417

RUN 1 (cont'd.)

SAMPLE OPERATING AND SUPPORT COST ESTIMATE
(MILLIONS OF FY77$)

YEAR	AC (PER AC)	O&M 0.38	MPN 0.24	APN 0.08	WPN 0.14	TOTAL 0.84
FY80	1.0	0.3	0.2	0.1	0.1	0.8
FY81	1.0	0.3	0.2	0.1	0.1	0.8
FY82	1.0	0.3	0.2	0.1	0.1	0.8
FY83	1.0	0.4	0.2	0.1	0.1	0.8
FY84	1.0	0.4	0.2	0.1	0.1	0.8
FY85	1.0	0.4	0.2	0.1	0.1	0.8
FY86	1.0	0.4	0.2	0.1	0.1	0.8
FY87	1.0	0.4	0.2	0.1	0.1	0.8
FY88	1.0	0.4	0.2	0.1	0.1	0.8
FY89	1.0	0.4	0.2	0.1	0.1	0.8
TOTAL	10.0	3.6	2.4	0.8	1.4	8.3

MORE ?
>Y

RUN 2

TERMINAL CHANGES

Assume that the user wants to investigate the O&S impact of a maintainability improvement. A typical one might be: raise DMMH/MO (#10) to 630, lower GTOW (#13) to 30.4, lower EW (#15) to 12.7, and lower flyaway cost (#21) to 3.9. The changes are input as follows:

```
        ENTER PARAMETER CHANGES (INDEX,VALUE)
                                DELIMITOR = 0,0
>10,630
>13,30.4
>15,12.7
>22,3.9
>0,0

        ENTER THRUPUT VALUES (INDEX,VALUE)
                                DELIMITOR = 0,0
>0,0

   DESCRIBE INPUT ?
>N
   PRINT INPUT?
>Y

     SAMPLE              22.14       9.52   1980.        10.         1.
               0.18       1.15       1.42      0.0     630.00      30.00
               2.30      30.40     600.00     12.70      16.00     400.00
               0.25       1.00       1.00     36.00       3.90     141.70
               1.00       0.0

       COMPUTED          13.02       2.57      1.60      16.73       1.62
              17.05     222.20     145.38    106.04     125.48     143.38
              33.46     138.61      59.84

     AC PER YR    1.0   1.0   1.0   1.0   1.0   1.0   1.0   1.0   1.0   1.0

   OK TO GO ?
>Y
```

SAMPLE OPERATING AND SUPPORT COST ESTIMATE
(THOUSANDS OF FY77$)

	AVERAGE ANNUAL COST PER UE	TOTAL COST 10 AC
TOTAL	805	7924
DEPLOYED UNIT OPS	153	1531
AIRCREWS(OFFICERS)	31	314
AIRCREWS(ENLISTED)	0	0
COMBAT COMMAND STF	15	149
POL	80	800
OTHER DEPLOYED MPN	24	244
AIR TAD	2	23
BELOW-DEPOT MAINT	176	1762
A/C MAINT MPN	124	1239
MAINTENANCE MAT'L	49	492
PERS SUP SUPPLIES	3	31
INSTALLATIONS SUP	12	117
BASE OPS SUPPORT	12	117
O&M BASE OPS	8	82
MPN BASE OPS	4	35
DEPOT MAINTENANCE	130	1173
COMPONENT REWORK	38	382
AIRFRAME REWORK	42	293
ENGINE REWORK	50	499
DEPOT SUPPLY	53	529
DEPOT SUPPLY OPS	11	113
TECHNICAL SUPPORT	42	416
2ND DEST TRANS	26	262
2ND DEST TRANS	26	262
PERS SUP & TRAIN	66	660
INDIVIDUL TRAIN	28	277
O&M	5	54
MPN	22	223
HEALTH CARE	15	145
O&M	7	70
MPN	8	75
PERS ACTIVITIES	24	238
O&M	1	11
MPN	23	227
SUS INVESTMENTS	189	1890
REPLEN SPARES	22	215
MODIFICATIONS	16	160
REPLEN GSE	10	97
TRAINING ORDNANCE	142	1417

RUN 2 (cont'd.)

SAMPLE OPERATING AND SUPPORT COST ESTIMATE
(MILLIONS OF FY77$)

YEAR	AC (PER AC)	O&M 0.37	MPN 0.25	APN 0.05	WPN 0.14	TOTAL 0.80
FY80	1.0	0.3	0.3	0.0	0.1	0.8
FY81	1.0	0.3	0.3	0.0	0.1	0.8
FY82	1.0	0.3	0.3	0.0	0.1	0.8
FY83	1.0	0.4	0.3	0.0	0.1	0.8
FY84	1.0	0.4	0.3	0.0	0.1	0.8
FY85	1.0	0.4	0.3	0.0	0.1	0.8
FY86	1.0	0.4	0.3	0.0	0.1	0.8
FY87	1.0	0.4	0.3	0.0	0.1	0.8
FY88	1.0	0.4	0.3	0.0	0.1	0.8
FY89	1.0	0.4	0.3	0.0	0.1	0.8
TOTAL	10.0	3.5	2.5	0.5	1.4	7.9

MORE ?
>N

17.48.16 >

APPENDIX F

```
C:          AIRMODL FORTRAN
      COMMON /DAT/ SDAT(42,40), STOT(42,5), ACY(42)
      COMMON /PAR/ APIN(30), APCM(20),   JP,JT,KT,    IN1, IN2
      COMMON /UTL/ ISC(40), ISQ(40), ISV(40), ISX(40)
      COMMON /WRD/ SNAM, SWD(5,39), PWD(5,39)
C:
      REAL*8  SNAM, COMP
      DIMENSION    PIN(25), PCM(14)
      EQUIVALENCE  (PIN,APIN), (PCM,APCM)
      DATA   COMP/'COMPUTED'/, NYES/'Y'/, NONO/'N'/, JC/14/
C:
    5 FORMAT(A1)
    9 FORMAT(10X,'** ? ? ? **')
   20 FORMAT(//4X,'DESCRIBE INPUT ? ')
   22 FORMAT(//5X,A8//5X,'INDEX',7X,'VALUE',6X,'DESCRIPTION'//
     1    (8X,I2,F12.2,6X,5A4) )
   30 FORMAT(4X,'PRINT INPUT? ')
   32 FORMAT(//6X,A8,5X,2F10.2,F8.0,2F10.0/(9X,6F10.2) )
   34 FORMAT(/8X,A8,3X,5F10.2/(9X,6F10.2) )
   38 FORMAT(//6X,'AC PER YR',1X,10F6.1/16X,10F6.1)
   40 FORMAT(//4X,'OK TO GO ? ')
   60 FORMAT(/4X,'MORE ? ')
C:
      CALL PIKFIL (IN1,IN2)
      IF (IN1.EQ.0)      RETURN
      CALL RDINP (IERR)
      IF (IERR.EQ.1)     RETURN
  100 CALL RDTHRU (IERR)
C:
      IF (KT.EQ.1.OR.PIN(5).EQ.0)    GO TO 200
      DO 152  I=2,KT
  152    ACY(I) = PIN(5)
C:
  200 CALL DOEQ
  220 WRITE (8,20)
      READ (5,5)    NYN
      IF (NYN.EQ.NONO)  GO TO 230
      IF (NYN.EQ.NYES)  GO TO 224
      WRITE (8,9)
      GO TO 220
  224 WRITE (8,22)  SNAM, (J,PIN(J),(PWD(I,J), I=1,5), J=1,JP)
      WRITE (8,22)  COMP, (J,PCM(J),(PWD(I,J+JP), I=1,5), J=1,JC)
      GO TO 238
C:
  230 WRITE (8,30)
      READ (5,5)    NYN
      IF (NYN.EQ.NONO)  GO TO 240
      IF (NYN.EQ.NYES)  GO TO 234
      WRITE (8,9)
      GO TO 230
```

```
  234 WRITE (8,32)  SNAM, PIN
      WRITE (8,34)  COMP, PCM
  238 WRITE (8,38)  (ACY(I), I=2,KT)
  240 WRITE (8,40)
      READ (5,5)  NYN
      IF (NYN.EQ.NYES)  GO TO 250
      IF (IN2.EQ.5)     GO TO 100
      GO TO 400
C:
  250 DO 298  JJ=1,JT
         J = ISO(JJ)
      DO 298  I=1,KT
         ANS = SDAT(I,J)
      IF (ISV(J).EQ.0.OR.I.GT.1)  CALL ESTM (I,J,ANS)
         SDAT(I,J) = ANS
      IF (ISC(J).EQ.0)  GO TO 270
         SDAT(I,ISC(J)) = SDAT(I,ISC(J)) + ANS
      IF (ISX(J).GT.1)  STOT(I,ISX(J)) = STOT(I,ISX(J)) + ANS
      GO TO 298
  270    STOT(I,1) = STOT(I,1) + ANS
  298 CONTINUE
C:
         ACY(KT+1) = 0.0
      DO 318  I=2,KT
         ACY(KT+1) = ACY(KT+1) + ACY(I)
      DO 308  J=1,5
  308    STOT(KT+1,J) = STOT(KT+1,J) + STOT(I,J)
      DO 318  J=1,JT
  318    SDAT(KT+1,J) = SDAT(KT+1,J) + SDAT(I,J)
C:
      CALL ACPRN
      IF (IERR.EQ.9)    GO TO 400
  320 WRITE (8,60)
      READ (5,5)  NYN
      IF (NYN.EQ.NONO)  GO TO 400
      IF (NYN.EQ.NYES)  GO TO 324
      WRITE (8,9)
      GO TO 320
  324    KTT = KT+1
      DO 338  I=1,KTT
      DO 328  J=1,5
  328    STOT(I,J) = 0
      DO 338  J=1,JT
      IF (ISV(J).EQ.0)  SDAT(I,J) = 0
      IF (I.EQ.KT+1)    SDAT(I,J) = 0
  338 CONTINUE
         ACY(KT+1) = 0
      GO TO 100
  400 RETURN
      END
```

```
      SUBROUTINE PIKFIL (IN1,IN2)
      REAL*8  KN1,KN2
      INTEGER*2   LN1(4), LN2(4), NN(3)
      EQUIVALENCE    (KN1,LN1), (KN2,LN2)
      DATA      NN/'3', '4', '5'/
    1 FORMAT(2A8)
   30 FORMAT(//10X,'FILE ID ERROR - RUN ABORTS',20X,2I2//)
   32 FORMAT(//10X,'EOF ON 5'//)
C:
      READ (5,1,END=112)  KN1, KN2
C:    WRITE (8,1)   KN1,KN2
         IN1 = 0
         IN2 = 0
      DO 102  N=1,3
      IF (LN1(1).EQ.NN(N))    IN1 = N+2
      IF (LN2(1).EQ.NN(N))    IN2 = N+2
  102 CONTINUE
      IF (IN1.EQ.3.OR.IN1.EQ.5)   GO TO 120
  110 WRITE (8,30)   IN1,IN2
         IN1 = 0
       RETURN
  112 WRITE (8,32)
      RETURN
  120 IF (IN2.LT.3.OR.IN2.GT.5)   GO TO 110
      RETURN
      END
```

```
      SUBROUTINE RDINP (IERR)
      COMMON /DAT/ SDAT(42,40), STOT(42,5), ACY(42)
      COMMON /PAR/ APIN(30), APCM(20),   JP,JT,KT,   IN1, IN2
      COMMON /UTL/ ISC(40), ISO(40), ISV(40), ISX(40)
      COMMON /WRD/ SNAM, SWD(5,39)
C:
      REAL*8  SNAM
      DIMENSION    PIN(25)
      EQUIVALENCE  (PIN,APIN)
C:
    1 FORMAT(/)
    2 FORMAT(A8)
   40 FORMAT(/10X,'ENTER ID (8 CHAR MAX)')
   42 FORMAT(/10X,'ENTER',I2,'PARAMETER VALUES')
   44 FORMAT(/10X,'ENTER AC VALUES FOR EACH YR (',I2,' VALUES)')
C:
      IF (IN1.EQ.5)      GO TO 200
      READ (IN1,2,END=118)   SNAM
      READ (IN1,*,END=118)   PIN
         KT = PIN(4)+1
      IF (KT.EQ.1.OR.PIN(5).GT.0)   GO TO 110
      READ (IN1,*,END=118)   (ACY(I), I=2,KT)
  110 RETURN
  118 WRITE (8,32)
   32 FORMAT(//10X,'INSUFFICIENT DATA IN INPUT FILE - RUN ABORTS'//)
         IERR = 1
      RETURN
C:
  200 WRITE (8,1)
      WRITE (8,40)
      READ (5,2)   SNAM
      WRITE (8,42)  JP
      READ (5,*)   PIN
         KT = PIN(4)+1
      IF (KT.EQ.1.OR.PIN(5).GT.0)   GO TO 290
         KTT = KT-1
      WRITE (8,44)   KTT
      READ (5,*)   (ACY(I), I=2,KT)
  290 RETURN
      END
```

```
      SUBROUTINE RDTHRU (IERR)
      COMMON /DAT/ SDAT(42,40), STOT(42,5), ACY(42)
      COMMON /PAR/ APIN(30), APCM(20),   JP,JT,KT,   IN1, IN2
      COMMON /UTL/ ISC(40), ISQ(40), ISV(40), ISX(40)
      COMMON /WRD/ SNAM, SWD(5,39)
C:
      REAL*8  SNAM
      DIMENSION    PIN(25)
      EQUIVALENCE  (PIN,APIN)
C:
    1 FORMAT(//)
   50 FORMAT(/10X,'ENTER PARAMETER CHANGES (INDEX,VALUE)'/
     1              35X,'DELIMITOR = 0,0' )
   52 FORMAT(/10X,'ENTER AC BY YR CHANGES (YR,VALUE)'/
     1   12X,'WHERE YR=1 THRU ',I2,' AND DELIMITOR = 0,0'/)
   54 FORMAT(/10X,'ENTER THRUPUT VALUES (INDEX,VALUE)'/
     1              35X,'DELIMITOR = 0,0' )
   58 FORMAT(4X,'** ? ? ? **')
C:
      IF (IN2.EQ.5)      GO TO 200
C:    CHECK CHANGES
      DO 112  J=1,JP
      READ (IN2,*,END=114)    JX, TMP
      IF (JX.EQ.0) GO TO 120
  112    PIN(JX) = TMP
  114    KT = PIN(4)+1
      GO TO 140
C:    CHECK AC CHANGES
  120    KT = PIN(4)+1
      IF (KT.EQ.1.OR.PIN(5).GT.0)    GO TO 130
      DO 122  I=2,KT
      READ (IN2,*,END=140)    IX, TMP
      IF (IX.EQ.0)    GO TO 130
  122    ACY(IX+1) = TMP
C:    CHECK THRUPUT
  130 DO 132  J=1,JT
      READ (IN2,*,END=140)    JX, TMP
      IF (JX.EQ.0) GO TO 138
         SDAT(1,JX) = TMP
  132    ISV(JX) = 1
  138 RETURN
  140    IERR = 9
      RETURN
C:
  200 WRITE (8,1)
  202 WRITE (8,50)
  204 CONTINUE
      READ (5,*,END=220)      JX, TMP
      IF (JX.GE.0.AND.JX.LE.JP)    GO TO 210
  208 WRITE (8,58)
      GO TO 202
  210 IF (JX.EQ.0) GO TO 220
         PIN(JX) = TMP
      GO TO 204
```

```
C:    AC CHANGES
  220     KT = PIN(4)+1
          KTT = PIN(4)
        IF (KT.EQ.1.OR.PIN(5).GT.0)    GO TO 240
  222 WRITE (8,52) KTT
  224 CONTINUE
        READ (5,*,END=240)    IX, TMP
        IF (IX.GE.0.AND.IX.LT.KT)    GO TO 230
  228 WRITE (8,58)
        GO TO 222
  230 IF (IX.EQ.0) GO TO 240
          ACY(IX+1) = TMP
        GO TO 224
C:    THRUPUT
  240 WRITE (8,54)
  244 CONTINUE
        READ (5,*,END=260)    JX, TMP
        IF (JX.GE.0.AND.JX.LE.JT)    GO TO 250
  248 WRITE (8,58)
        GO TO 244
  250 IF (JX.EQ.0) GO TO 260
          SDAT(1,JX) = TMP
          ISV(JX) = 1
        GO TO 244
  260 RETURN
        END
        SUBROUTINE DOEQ
        COMMON /PAR/ FP,EP,FY,YRS,AC, OOP,CSE,OCA,ECA,PMO,FM, AT,GT,SA,EW
       1    ,TE, DAR,ORR,TD,EN,P, FC,TO,TBF,AVD,    XTI(5)
       2    ,PMT,OEP,TDO,TDE,POF,PEN,POL, OOC,CR,AR,ERO,ERM,ERT, RS
       3    ,PAL,    XTC(5)
        DATA    NA/12/
C:
          PMT = 1.66975 + .018009*PMO
          OEP = (-6.03260 + 2.6771*SQRT((OOP+CSE+OCA+PMT+ECA)*NA))/NA
          TDO = OOP + OCA
          TDE = OEP + CSE + ECA + PMT
          PAL = TDO + TDE
          POF = TDO + .00129750*PAL
          PEN = TDE + .017210954*PAL
          POL = EXP(-1.2084 + .4403*ALOG(GT) + .7986*ALOG(SA))
          OOC = -22.6417 + 0.1323*SA + 0.1407*PMO
          CR  = 43.2996 + 2.9875*(PMO/FM) + 174.550*AVD
          AR  = -54.9255 + 0.1574*PMO + 0.1354*SA
          ERO = 28.875 + 87.787*TD + 1.67*TE
          ERM = 12.5968 + 7.8157*TD + 0.8153*TE
          ERT = EN * 1000.*(ORR*ERO + ERM) / ( (1.+ORR) * DAR )
          RS  = 4.5 * (-2.915 + 0.0194*SA + 0.00726*PMO)
        RETURN
        END
```

```
      SUBROUTINE ESTM (I,J,ANS)
      COMMON /DAT/ SDAT(42,40), STOT(42,5), ACY(42)
      COMMON /PAR/ FP,EP,FY,YRS,AC, DOP,CSE,DCA,ECA,PMO,FM, AT,GT,SA,EW
     1   ,TE, DAR,ORR,TD,EN,P, FC,TO,TBF,AVD,   XTI(5)
     2   ,PMT,DEP,TDO,TDE,POF,PEN,POL, DOC,CR,AR,ERO,ERM,ERT, RS
     3   ,PAL,   XTC(5)
C:
      XTR = ANS
      ANS = 0.0
      LAG = 0
      IF (I.EQ.1)  GO TO 90
      GO TO (9,80,80,80,80,80,80,9,80,80,80,9,9,80,80,9,80,58,80
     1    ,9,80,80,9,80,9,9,80,80,9,80,80,9,80,80,9,80,80,80,80),  J
   58 LAG = P/12
   80 IF (LAG.GE.I)     GO TO 9900
      ANS = SDAT(1,J)*ACY(I-LAG)
      GO TO 9900
C:
   90 GO TO (9,200,300,400,500,600,700,9,900,1000,1100,9,9,1400,1500,9
     1   ,1700,1800,1900,9,2100,2200,9,2400,9,9,2700,2800,9,3000
     2   ,3100,9,3300,3400,9,3600,3700,3800,3900),  J
    9 ANS = XTR
      GO TO 9900
C:
  200 ANS = FP*DCA
      GO TO 9900
  300 ANS = EP*ECA
      GO TO 9900
  400 ANS = FP*DOP + EP*CSE
      GO TO 9900
  500 ANS = POL
      GO TO 9800
  600 ANS = EP*DEP
      GO TO 9900
  700 ANS = AT
      GO TO 9900
C:
  900 ANS = EP*PMT
      GO TO 9900
 1000 ANS = 0.940*DOC
      GO TO 9800
 1100 ANS = 0.060*DOC
      GO TO 9800
C:
 1400 ANS = .878 + .507511145*PAL
      GO TO 9900
 1500 ANS = (.00129750*FP + .017210954*EP)*PAL
      GO TO 9900
C:
 1700 ANS = CR
      GO TO 9800
 1800 ANS = AR*12/P
      GO TO 9900
 1900 ANS = ERT
      GO TO 9800
C:
```

```
 2100    ANS = .024656*(SDAT(1,5)+SDAT(1,10)+SDAT(1,11)+SDAT(1,16) )
         ANS = ANS + .024656*(FP*(DDP+DCA)+EP*(DEP+CSE+ECA+PMT))
         GO TO 9900
 2200    ANS = .28193*SDAT(1,36) + .000018*12*FM + .13759*SDAT(1,16)
         TMP = SDAT(1,5)+SDAT(1,10)+SDAT(1,11)+SDAT(1,16)+SDAT(1,36)
         ANS = ANS + .19411*TMP -SDAT(1,21) - SDAT(1,24)
         GO TO 9900
C:
 2400    ANS = .057243*(SDAT(1,5)+SDAT(1,10)+SDAT(1,11)+SDAT(1,16)
     1       + (FP*(DDP+DCA) + EP*(DEP+CSE+ECA+PMT)) )
         GO TO 9900
C:
 2700    ANS = .878*(.00449108*PEN+.079824603*PDF+.31872502*(PEN+PDF))
         GO TO 9900
 2800    ANS = .0001471405*PEN + .00267258*(PEN+PDF) + .0604742*PDF
         TMP = .09335298*PEN + .02089893*(PEN+PDF) + .0066795543*PDF
         ANS = FP*ANS + EP*TMP
         GO TO 9900
C:
 3000    ANS = .878 * .42882495*(PDF+PEN)
         GO TO 9900
 3100    ANS = (.00992728*FP + .01921098*EP) * (PEN+PDF)
         GO TO 9900
C:
 3300    ANS = .878 * .07237338*PEN
         GO TO 9900
 3400    ANS = FP*((.06055605 + .00083299)*PDF + .00088065*PEN)
         ANS = ANS + EP*(.04469998+.00724283+.01242349)*PEN
         ANS = ANS + .878 * (1.47265*PDF + .50796*PEN)
         GO TO 9900
C:
 3600    ANS = RS
         GO TO 9800
 3700    ANS = 4.1 * FC
         GO TO 9900
 3800    ANS = 2.5 * FC
         GO TO 9900
 3900    ANS = TD
         GO TO 9900
C:
 9800    ANS = ANS * 12*FM/1000.
 9900 RETURN
      END
```

```
      SUBROUTINE ACPRN
      COMMON /DAT/ SDAT(42,40), STOT(42,5), ACY(42)
      COMMON /PAR/ APIN(30), APCM(20),   JP,JT,KT,   IN1, IN2
      COMMON /UTL/ ISC(40), ISO(40), ISV(40), ISX(40)
      COMMON /WRD/ SNAM, SWD(5,39)
C:
      REAL*8  SNAM, WTOT(5), SY(56)
      DIMENSION    PIN(24)
      EQUIVALENCE  (PIN,APIN)
C:
C:
      DATA    WTOT/'TOTAL','  O&M','  MPN','  APN','  WPN'/
      DATA    SY/' FY71',' FY72',' FY73',' FY74',' FY75',' FY76',' FY77'
     1   ,' FY78',' FY79',' FY80',' FY81',' FY82',' FY83',' FY84'
     2   ,' FY85',' FY86',' FY87',' FY88',' FY89',' FY90',' FY91'
     3   ,' FY92',' FY93',' FY94',' FY95',' FY96',' FY97',' FY98'
     4   ,' FY99',' FY00',' FY01',' FY02',' FY03',' FY04',' FY05'
     5   ,' FY06',' FY07',' FY08',' FY09',' FY10',' FY11',' FY12'
     6   ,' FY13',' FY14',' FY15',' FY16',' FY17',' FY18',' FY19'
     7   ,' FY20',' FY21',' FY22',' FY23',' FY24',' FY25',' FY26'/
C:
    1 FORMAT(/)
    2 FORMAT(///)
    3 FORMAT(1H )
   10 FORMAT(//20X,A8,' OPERATING AND SUPPORT COST ESTIMATE'/
     1         36X,'(THOUSANDS OF FY77$)'/)
   12 FORMAT(32X,'AVERAGE ANNUAL',5X,'TOTAL COST'/35X,'COST PER UE'
     1       ,5X,I5,' AC')
   18 FORMAT(/22X,'TOTAL',10X,I9,I15)
   20 FORMAT(//20X,A8,' OPERATING AND SUPPORT COST ESTIMATE'/
     1          37X,'(MILLIONS OF FY77$)'//)
   22 FORMAT(8X,'YEAR',8X,'AC',5(5X,A5)/15X,'(PER AC)',F9.2,4F10.2/)
   24 FORMAT(7X,A5,6F10.1)
   32 FORMAT(/14X,4A4,A2,5X,I9,I15/)
   34 FORMAT(16X,4A4,A2,3X,I9,I15)
   36 FORMAT(18X,4A4,A2,1X,I9,I15)
C:
      KTT = KT + 1
      ICY = ACY(KTT) + 0.5
      IDAT1 = STOT(1,1) + 0.5
      IDAT2 = STOT(KTT,1) + 0.5
      WRITE (8,1)
      WRITE (8,10)   SNAM
      WRITE (8,12)   ICY
      WRITE (8,18)   IDAT1, IDAT2
C:
```

```
  250 DO 278  J=1,JT
         NS = J
      DO 252  N=1,3
      IF (ISC(NS).EQ.0) GO TO 260
  252    NS = ISC(NS)
         N = 3
  260    IDAT1 = SDAT(1,J) + 0.5
         IDAT2 = SDAT(KTT,J) + 0.5
      GO TO (272,274,276),  N
  272 WRITE (8,32)  (SWD(I,J), I=1,5), IDAT1, IDAT2
      GO TO 278
  274 WRITE (8,34)  (SWD(I,J), I=1,5), IDAT1, IDAT2
      GO TO 278
  276 WRITE (8,36)  (SWD(I,J), I=1,5), IDAT1, IDAT2
  278 CONTINUE
C:
      DO 308  I=1,KTT
      DO 308  J=1,5
  308    STOT(I,J) = STOT(I,J)/1000.
      WRITE (8,2)
      WRITE (8,20)   SNAM
      WRITE (8,22)   (WTOT(J),  J=2,5), WTOT(1)
     1               ,(STOT(1,J), J=2,5), STOT(1,1)
         IFY = PIN(3) - 1972
      DO 318  I=2,KT
  318 WRITE (8,24)   SY(I+IFY), ACY(I), (STOT(I,J), J=2,5), STOT(I,1)
      WRITE (8,3)
      WRITE (8,24)   WTOT(1), ACY(KTT), (STOT(KTT,J), J=2,5)
     1              ,STOT(KTT,1)
      WRITE (8,2)
      RETURN
      END
```

```
 BLOCK DATA
 COMMON /DAT/ SDAT(42,40), STOT(42,5), ACY(42)
 COMMON /PAR/ APIN(30), APCM(20),   JP,JT,KT,    IN1, IN2
 COMMON /UTL/ ISC(40), IS0(40), ISV(40), ISX(40)
 COMMON /WRD/ SNAM, SD1(5,19), SD2(5,5), SD3(5,15)
+      ,PD1(5,11), PD2(5,14), PD3(5,14)

 REAL*8  SNAM

 DATA   SDAT/1600*0.0/, STOT/210*0.0/, ACY/42*0.0/
1   ,APIN/30*0.0/, APCM/20*0.0/
 DATA   JP/25/, JT/39/, KT/0/, IN1/0/, IN2/0/
 DATA   ISC/0,6*1, 0,3*8, 0,12,2*13, 0,3*16, 0,2*20, 0,23
+   ,0,25,2*26,25,2*29,25,2*32, 0,4*35/
 DATA   IS0/19,18,17,16,15,14,13,12,11,10,9,8,7,6,5,4,3,2,1, 39,38
1    ,37,36,35,34,33,32,31,30,29,28,27,26,25,24,23,21,22,20/
 DATA   ISX/1,3*3,2,3,2, 1,3,2,2, 1,1,2,3, 1,3*2, 1,2*2, 1,2
1    ,1,1,2,3,1,2,3,1,2,3, 1,3*4,5/,   ISV/40*0/

 DATA    PD1/'MPN','RATE',' (OF','F)',' '
2   ,'MPN','RATE',' (EN','L)',' '
3   ,'STAR','TING',' FY',' ',' '
4   ,'# OF',' YEA','RS',' ',' '
5   ,'# A/','C PE','R YR',' ',' '
6   ,'CCS','OFFI','CERS',' ',' '
+   ,'CCS','ENLI','STED',' ',' '
7   ,'OFF','CREW',' ALL','OWAN','CE'
8   ,'ENL','CREW',' ALL','OWAN','CE'
9   ,'MAIN','T MH','R/MO',' ',' '
+   ,'FLYI','NG H','RS/M','O',' '/
 DATA    PD2/'AIR','TAD',' (000','$)',' '
2   ,'GROS','S T/','O WT',' (000',' LBS)'
3   ,'MAX','SPEE','D (AL','T KT','S)'
4   ,'EMPT','Y WT',' (00','0LBS',')'
5   ,'THRU','ST/E','NG (0','00LB','S)'
6   ,'DEP','ENG','ARR','RT (','HRS)'
7   ,'OVHL','/REP','AIR','RATI','O'
8   ,'ENG','TYP (','0JET',' 1FA','N)'
9   ,'# OF',' ENG','INES',' ',' '
+   ,'A/C','RW C','YCLE',' (MO','S)'
1   ,'FLYA','WAY','COST',' (MI','L)'
2   ,'TRNG',' ORD','N (T','HOUS',')'
3   ,'MEAN',' TIM','E-B-','F (H','RS)'
4   ,'AVIO','NICS',' DUM','MY (','0,1)'/
 DATA    PD3/'A/C','MAIN','T MP','WR',' '
2   ,'OTHE','R DE','PL M','PWR',' '
3   ,'TOTA','L DI','R OF','F MP','WR'
4   ,'TOTA','L DI','R EN','L MP','WR'
5   ,'INDI','RECT',' OFF',' MPW','R'
6   ,'INDI','RECT',' ENL',' MPW','R'
7   ,'POL','($/F','H)',' ',' '
```

```
8    ,'MM &',' PSS',' ($/',FH)',' '
9    ,'COMP',' REW',' ($/',FH)',' '
*    ,'A/C','REW','(000','$/RE','W)'
1    ,'ENG','OVH','(000','$/EN','G)'
2    ,'ENG','REP','(000','$/EN','G)'
3    ,'ENG','COST',' ($/',FH)',' '
4    ,'REPL',' SP',' ($/',FH)',' '/

 DATA   SD1/'DEPL','OYED',' UNI','T OP','S'
2    ,'AIRC','REWS','(OFF','ICER','S)'
3    ,'AIRC','REWS','(ENL','ISTE','D)'
4    ,'COMB','AT C','OMMA','ND S','TF'
5    ,'POL',' ',' ',' ',' '
6    ,'OTHE','R DE','PLOY','ED M','PN'
7    ,'AIR','TAD',' ',' ',' '
8    ,'BELO','W-DE','POT','MAIN','T'
9    ,'A/C','MAIN','T MP','N',' '
*    ,'MAIN','TENA','NCE',4HMAT','L'
1    ,'PERS',' SUP',' SUP','PLIE','S'
2    ,'INST','ALLA','TION','S SU','P'
3    ,'BASE',' OPS',' SUP','PORT',' '
4    ,'O&M','BASE',' OPS',' ',' '
5    ,'MPN','BASE',' OPS',' ',' '
6    ,'DEPO','T MA','INTE','NANC','E'
7    ,'COMP','ONEN','T RE','WORK',' '
8    ,'AIRF','RAME',' REW','ORK',' '
9    ,'ENGI','NE R','EWOR','K',' '/

 DATA   SD2/'DEPO','T SU','PPLY',' ',' '
1    ,'DEPO','T SU','PPLY',' OPS',' '
2    ,'TECH','NICA','L SU','PPOR','T'
3    ,'2ND','DEST',' TRA','NS',' '
4    ,'2ND','DEST',' TRA','NS',' '/

 DATA   SD3/'PERS',' SUP',' & T','RAIN',' '
5    ,'INDI','VIDU','L TR','AIN',' '
6    ,'O&M',' ',' ',' ',' '
7    ,'MPN',' ',' ',' ',' '
8    ,'HEAL','TH C','ARE',' ',' '
9    ,'O&M',' ',' ',' ',' '
*    ,'MPN',' ',' ',' ',' '
1    ,'PERS',' ACT','IVIT','IES',' '
2    ,'O&M',' ',' ',' ',' '
3    ,'MPN',' ',' ',' ',' '
4    ,'SUS','INVE','STME','NTS',' '
5    ,'REPL','EN S','PARE','S',' '
6    ,'MODI','FICA','TION','S',' '
7    ,'REPL','EN G','SE',' ',' '
8    ,'TRAI','NING',' ORD','NANC','E'/
 END
```